SCIENTIFIC AMERICAN

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THE NEW BRIDGE OVER THE HUDSON RIVER AT NEW YORK.

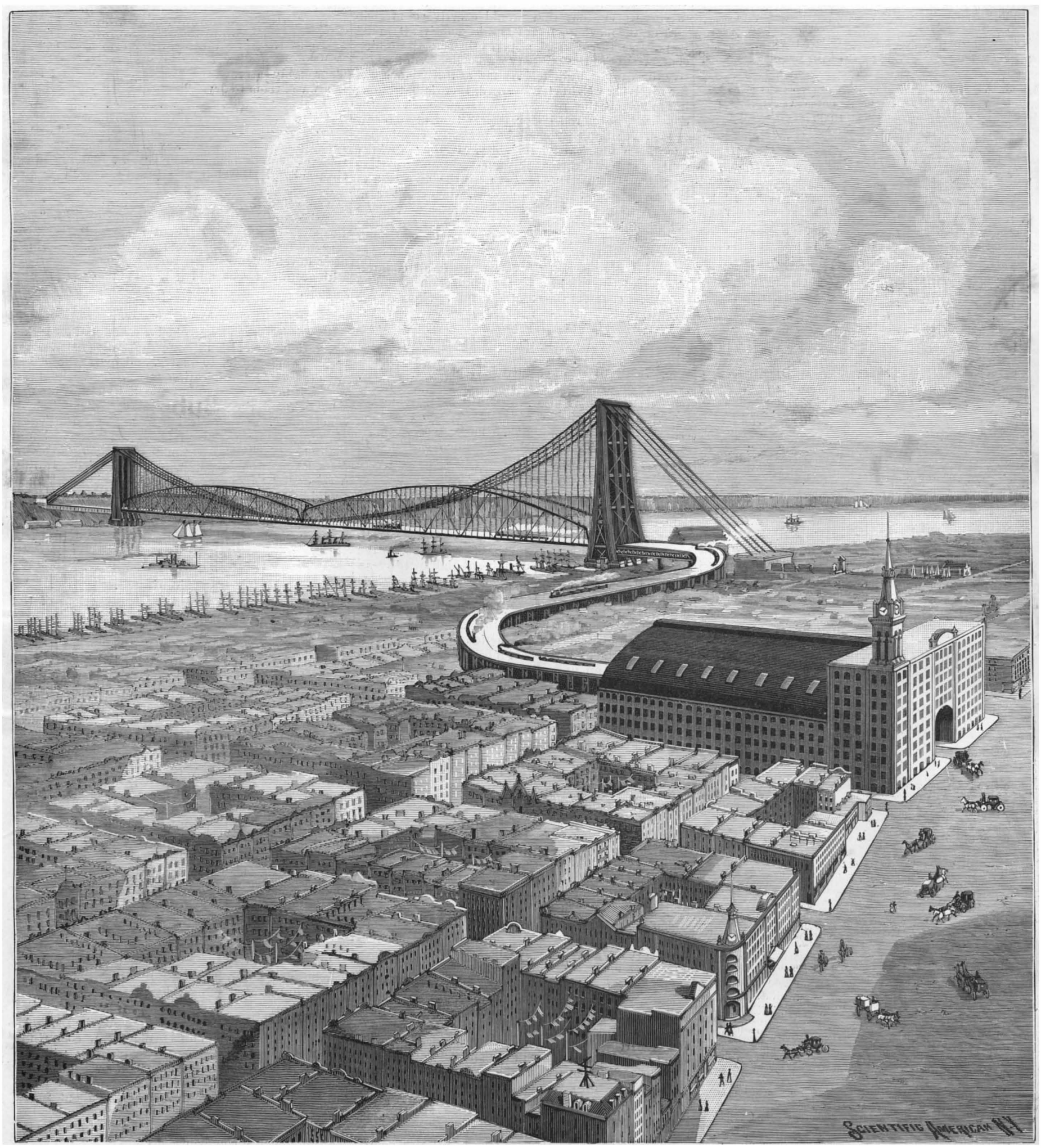
We present a perspective view of the proposed New York and New Jersey railroad bridge across the Hudson River It shows also the New York approaches and the location of the grand terminal station.

The station will be at the corner of Eighth Avenue, Forty-ninth and Fifty-first Streets. The six track viaduct will run thence west to the block in Fiftieth Street between Tenth and Eleventh Avenues. There, by a broad curve, the viaduct will sweep northward, constantly rising at a grade of thirty-five feet to the mile. The structure will curve to the westward again at Fifty-eighth Street, and at Fifty-ninth Street and Twelfth Avenue it will reach the end of the bridge structure proper.

The imposing proportions of the bridge and the beauty of its designs are shown in the illustration, and, when we study its dimensions in detail, it is perhaps safe to say that it will be the greatest engineering work ever attempted. This can best be understood by reference to the present Brooklyn Bridge. The main span of the new bridge will be more than twice the length and its towers fully twice the height of those of the Brooklyn Bridge.

It was originally proposed to erect a bridge of the cantilever system, with a river span of 2,000 feet. This would have necessitated a tower 1,000 feet out in mid-stream, and, as the War Office requirements demanded

(Continued on page 279.)



THE NEW BRIDGE OVER THE HUDSON RIVER AT NEW YORK.

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THE DESTRUCTIVE ACTION OF LOCOMOTIVE DRIVING WHEELS.

The rapid acceleration of railway speed which has taken place in the last few years has developed some new problems in the design of the locomotive; or, to speak more correctly, it has brought into prominent notice certain details of design which, in the earlier locomotives, received but little attention. A sixty-five ton locomotive at rest and a sixty-five ton locomotive running over the track at eighty miles an hour are two very different things. In their action upon the steel rail and the roadbed, there is all the difference between static and dynamic forces, and this difference will increase with the increase of speed. The builders of the early locomotives understood this, no doubt, as well as we do today, but, at the speeds at which they ran their trains, the variations of wheel pressures were not so serious as to call for special attention. The proper counterbalancing of a locomotive is, for obvious reasons, a more difficult problem than that of counterbalancing a stationary engine. The latter is bolted rigidly to a solid bed; whereas the locomotive is hung upon springs, and the whole machine is capable of violent lateral, vertical, and longitudinal oscillations. If it were possible so to arrange the weights in the driving wheels that they would exactly counterbalance all the moving parts of the locomotive, it would be possible to construct a perfectly smooth running engine. But in the ordinary two-cylindered locomotive this cannot be done. As far as the balancing of the revolving weights is concerned, there is no trouble; but to balance the reciprocating parts, such as the crosshead, piston rod, piston, etc., so that at all points of the revolution they shall be perfectly counterbalanced, is a physical impossibility. If they are fully counterbalanced when at the half stroke and traveling at their maximum speed, there will be an excess of counterbalance at the dead centers, when they are at rest. Among the earlier builders it was a common practice to counterbalance all the reciprocating parts; and, on some roads, this is still the practice, though it is more usual to counterbalance only from one-half to two-thirds of these weights. If they are all counterbalanced, there will be a hammering action set up by the excess counterbalance at the full stroke. At the downward half of the revolution, its effect on the driving wheel in which it is located will be to increase the pressure on the rail; and on the upward half it will tend to lift the wheel and so reduce the total pressure. So that instead of the wheel bearing upon the rail with an even pressure, equal at all times to the tension of the springs, it will vary with a range increasing with the velocity of rotation. As the speed increases, this action will become more dynamic in its effect, until a point is reached at which variation in pressure will be so great and so rapid as to set up a positive hammering action upon the rails.

When engineers first began to come in off their runs and complained that at high speed the driving wheels would occasionally lift entirely clear of the rails, the statement was received either with incredulity or ridicule. But when it was found that in a certain case the passage of a badly balanced engine at high speed over a piece of track left a series of regularly spaced depressions in the rail, showing that it had been bent down out of level at these points, locomotive builders began to understand how destructive was this action, and that a force which in its downward action could bend and give a permanent set to a 70 pound rail might conceivably exert an upward pressure greater than the load upon the wheel, and sufficient to lift it clear of the track.

A force that bends a cold steel rail to such an extent as to leave a permanent set in it is destructive to the bridges on a line. This is shown by the sudden snapping of tie rods at the moment when an overbalanced engine is passing at high speed. These rods are designed to be proportional in strength to the static load of the locomotive and train. The greatest concentration of load is that of the driving wheels; and there are thousands of bridges in existence which have been designed on the assumption that the static load of say from 15 to 20 tons on the drivers was the highest concentration to which they would be subjected. Yet, as a matter of fact, these same bridges are liable to be subjected to the hammering action of an engine which strikes a series of blows of not less than 40 or 50 tons weight.

The evils of overbalancing may be avoided, or reduced to a minimum, in two ways—first by reducing the weight of the reciprocating parts to the lowest practicable limit, and second by counterbalancing only a part of their total weight. There is no doubt but that the weight of pistons, crossheads, and slide valves could in many cases be greatly reduced. Weight could be saved in the case of the piston by designing it in forms which allowed a minimum amount of material to be disposed to the best possible advantage for strength, and also by making it of the highest grade of material. A great saving of weight could be made over the cast iron pistons which have been so largely employed. The same thing is true in a lesser degree of the whole of the reciprocating parts. In many cases a total saving of thirty to forty per cent could be made on the present weight. With the weight thus reduced it would not be necessary to counterbalance for more than fifty per cent of it; and in the case of heavy engines the percentage could be less than this.

Of course, the unbalanced weight will tend to produce a fore-and-aft oscillation; but this weight will be relatively so small that it will scarcely affect the mass of the engine as a whole.

There is one other element, the size of the driving wheel, which greatly affects the question of balancing. For high speeds it should be made as large as is consistent with a reasonable amount of starting power. The downward blow of the excess balance will vary, other things being equal, with the diameter of the driving wheel, and this is one of the causes, among others, which have led American designers to adopt larger wheels for the latest types of high speed locomotives.

Enlarging on Canvas.

Mrs. Allen gives in the St. Louis and Canadian Photographer the following method of enlarging upon canvas: Wash canvas in hot water, rinse with cold, after which stretch to remove all folds. Salting solution:

Potassium bromide	3 parts
Potassium iodide	1 part
Cadmium bromide	1 "
Water	240 parts

Thoroughly saturate the canvas with this, and hang in a warm room to dry. Then sensitize with

Nitrate of silver	4 parts
Citric acid	1 part
Water	140 parts

Sensitizing is done same way as salting. Expose in solar camera, or in a similar camera illuminated by electric light. Develop the exposed canvas in

Pyrogallic acid	10 parts
Citric acid	4 "
Water	410 "

Use slightly warm, and about ten minutes is necessary to bring out the picture, thoroughly washing after development. Tone same way as silver prints, with acetate of soda and gold. Fix in hyposulphite of soda.

Slate for Houses.

Slate is too much overlooked as a material for inside decoration. It exists in many different shades. It is easy and inexpensive to quarry, and, by far the easiest stone to shape into pleasing forms. These qualities render it the cheapest of durable materials for interior purposes, and the wonder is that so little of it is in common use. If large dealers would establish depots of standard goods made up for combination in house building in such forms as would be available to architects, its use would be indefinitely extended. Hardly a cottage of any pretensions would be built where it would not take a prominent part. If such depots were established, house builders would be enabled to see it, and appreciate its beauty and cheapness. As it is, hardly one in five hundred knows anything of either.—Stone.

British Association.

The ten presidents for the various sections of the British Association meeting in Liverpool next September have now been chosen. They are Prof. J. J. Thomson, F.R.S., Mathematical and Physical Science Section; Dr. Ludwig Mond, F.R.S., Chemistry; Mr. John E. Marr, F.R.S., Geology; Prof. E. C. Poulton, F.R.S., Zoology; Major Leonard Darwin, Geography; the Right Hon. Leonard Courtney, M.P., Economics; Sir Charles Douglas Fox, M.Inst.C.E., Mechanical Science; Mr. Arthur Evans, F.S.A., Anthropology; Dr. Walter Holbrook Gaskell, F.R.S., Physiology and Pathology; and Dr. D. H. Scott, F.R.S., Botany. Prof. Flinders Petrie, and probably Sir Andrew Noble, will deliver the evening discourses, and Prof. Fleming, F.R.S., will give the lecture to workingmen.

AT the Am Urban Hospital in Berlin 411 diphtheria patients were treated in 1894-95, 255 of whom were discharged cured. Of 245 treated with serum, 28 per cent died, while among the 146 who were treated otherwise the mortality was 42 per cent; 53·2 of the serum cases were serious, 23 7 severe, and the rest slight. No evil effects were observed to follow the use of the serum, and its effectiveness was proportionate to the earliness of its application and the strength of the first doses. The hospital authorities infer from this that it is not an infallible, but a highly valuable remedy.

THE Brooklyn Institute has purchased the Berthold-Neumoegen Collection of Lepidoptera, comprising 40,000 to 45,000 specimens. The institute will also secure the collection of Jacob Doll, of over 55,000 specimens, and will employ Mr. Doll as curator. Edward L. Graef will present his collection of about 20,000. The institution already owns the Calvarey collection, so that altogether the institution will have, says Nature, the most complete collection of lepidoptera in the world.

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THE SKY IN MAY.

BY GARRETT P. SERVISS.

During this month a splendid opportunity will be afforded for seeing the planet Mercury after sunset, an opportunity which no one should lose, because Mercury, on account of its proximity to the sun, is difficult to catch sight of except under very favorable conditions. It will be visible in the west all the month, but will be best seen about the middle, when it is at its greatest distance from the sun. It attains its greatest eastern elongation on the 16th, when it will be seen shining between the horns of Taurus, a few degrees south of the second magnitude star, β, or El Nath. With a telescope it will then appear in the form of a half moon. Although Mercury is probably at all times an exceedingly hot world on account of its nearness to the sun, yet its orbit is so eccentric that the solar light and heat received on its surface vary to an enormous extent, being more than twice as great at one time as at another, and passing from one extreme to the other in the short space of six weeks. At the time when Mercury is most conspicuous in the sunset sky, about the middle of May, it will be passing from perihelion, a point reached on the 25th of April, toward aphelion, which will be attained on the 8th of June.

While Mercury is on exhibition as an evening star, Venus, the typical evening star when it lies eastward from the sun, will remain inconspicuous in the morning sky, gradually drawing nearer to the sun, behind which it will pass early in July. At the beginning of the month Venus will be in Pisces; at the end in Taurus.

Mars is a morning star, moving slowly in the course of the month from Aquarius into Pisces, and at the close of the month it will rise about 1 o'clock in the morning.

Jupiter, remaining in Cancer, and slowly drawing nearer the "Beehive" cluster, will continue to be the most brilliant planet in sight throughout the month, and, in fact, throughout the early part of summer. Castor and Pollux in the Twins are so near the great planet that its presence serves to point out those famous stars to persons unfamiliar with the constellations. Being brighter than any fixed star, Jupiter ought to be readily identified, but there is an easy way for those who possess a strong field glass or spy glass to make the identification doubly sure. Such an instrument cannot fail to show one or more of Jupiter's moons, and, in favorable circumstances, all of the four principal moons.

Saturn, in the constellation Libra, rises early in the evening, and by 9 or 10 o'clock is in an excellent position for observation. Being in opposition to the sun, it is, roughly speaking, at its nearest point to the earth, and, consequently, most favorably situated for telescopic study. The earth is not quite so far north of the plane of the rings as it was at the end of winter, but the change is not sufficient to cause the rings to appear to the ordinary observer appreciably narrower, and, in fact, the whole planet, in all its dimensions, looks a trifle larger on account of its nearer approach.

Uranus is also in Libra, nearly between the fourth magnitude stars γ and ι. Coming into opposition on the 12th, it should be visible to the naked eye, but, in order to identify it, the observer should watch it with a field glass, and note its position from night to night in relation to small stars near it. For those who may wish to find it with the aid of a star atlas, I give its approximate right ascension and declination for the beginning, middle and end of the month: On May 1, R. A. 15 h. 22 m., Dec. S. 18° 14′; on May 15, R. A. 15 h. 20 m., Dec. S. 18° 6′; on May 31, R. A. 15 h. 17 m., Dec. S. 17° 56′.

Neptune is in Taurus and Mercury will be near it at the middle of May.

The new moon of May occurs on the afternoon of the 12th; first quarter on the morning of the 20th; full moon on the afternoon of the 26th, and last quarter (the last of the April moon) on the forenoon of the 4th. The moon is in perigee on the 24th and in apogee on the 8th.

The moon's monthly calls on the planets strung along the zodiac will take place as follows: Mars on the 7th; Venus on the 11th; Mercury on the 14th; Neptune on the 14th; Jupiter on the 18th; Saturn on the 25th; Uranus on the 25th.

A peculiarity of the starry heavens in the evenings of the month of May is that then the Galaxy, or Milky Way, lies stretched level upon the northern horizon, extending from Scorpio in the southeast around under the pole to Monoceros in west. In the city, or in any neighborhood where electric lights are clustered, of course this phenomenon is practically invisible, but it should be easily seen on a clear moonless night in the open country, unless hidden behind nearby hills.

For the benefit of those using small telescopes I append a few phenomena of Jupiter's satellites, and also of those five of Saturn's satellites which telescopes of moderate size may be expected to show.

On May 1, at 7:37 P. M., Satellite I will enter on the edge of the disk of Jupiter, and at 8:52 P. M. its shadow will follow it upon the disk. A little before 9:50 P. M. Satellite II will reappear from eclipse in Jupiter's shadow, and about seven minutes later Satellite I will pass off the disk, its shadow following it off at 11:12 P. M.

On May 8, at 9:33 P. M., Satellite I will enter upon the disk, and twenty-three minutes later the shadow of Satellite IV, which will have been crossing the disk since late in the afternoon, will pass off. At about 10:42 P. M. Satellite III will reappear from eclipse, having passed into Jupiter's shadow soon after seven o'clock in the evening. At 10:47 P. M. the shadow of Satellite I will enter upon the disk.

On May 15, at 9:46 P. M., Satellite II will disappear behind Jupiter, and nine minutes later Satellite III will reappear from behind the opposite edge of the planet. At 11:08 P. M. Satellite III will disappear in Jupiter's shadow.

In the following list the satellites of Saturn are mentioned in the order of their distance from the planet, beginning with the nearest of the five. The times are approximate: Tethys will be at its greatest eastern elongation on the 12th at 11:15 P. M., on the 14th at 8:30 P. M., on the 29th at 10:56 P. M., and on the 31st at 8:15 P. M. Dione will be at its greatest eastern elongation on the 2d at 9:50 P. M., and on the 13th at 8:30 P. M. Rhea will be at its greatest eastern elongation on the 14th at 8:15 P. M. and on the 23d at 8:50 P. M. Titan is so easily seen that it is hardly necessary to give its times of elongation. It will be east of the planet on the evening of the 2d, west of it on the evening of the 10th, and north of it on the evening of the 14th. Japetus will be near its western elongation, the position in which, owing to some peculiarity of its surface, it is best seen, during the first week of the month. It is just at the elongation point at five o'clock on the morning of the 4th of May.

Spontaneous Combustion.

BY G. D. HISCOX.

Although many of the mysterious fires attributed to spontaneous combustion may have originated in some other way, there can be no doubt, from the long record of facts, that a large proportion of such fires are really due to this cause.

The reduction of fire risks is a most important point of economy and of vital interest to many manufacturers, or others that make use of any material or stock that is liable to be made combustible by the application of oil of any kind for facilitating its manufacture. The first care is to guard against the accumulation of such material or stock while in an oily condition, in heaps or in contact with heating pipes, or even in iron receptacles, without providing against its accumulation of heat by its absorption of oxygen from the air. This may be done by spreading such stock so as to secure a cooling effect from an extended air contact and circulation.

In the case of oily waste and rags, especially with painters' rags, one of the most dangerous of this class, when allowed to accumulate, oily sawdust, or any vegetable or woody fiber used for cleaning machinery or the wiping up of waste oil, the only safety is found in its immediate immersion in water.

Oily waste and rags holding any of the lubricating compounds so much in use in engine rooms and on locomotives are perhaps the most dangerous materials to be cared for, but when thrown into out of the way places, they readily become the originators of mysterious fires.

We have often seen the results of throwing a handful of oily waste from a locomotive upon the ties or into the grass at the roadside, which, taking fire in an hour or two, has set fire to ties or grass. Perhaps not a few wooden railroad bridges have been mysteriously set on fire in this way. Journal drippings in flour mills and saw mills are no doubt the cause of many mill fires; started by the accumulation of flour dust or fine floating sawdust upon oily surfaces around journal boxes or where the drippings fall. Dust of any kind from fiber or wood as found in cotton and jute mills, woolen mills and woodworking factories becomes in this manner a source of danger.

The increasing use of cotton seed oil, and the fact that its properties are but little known by the users, is a new source of danger, and needs great caution in exposing it to the conditions favorable for spontaneous combustion.

Like linseed and other vegetable oils, the sprinkling of wool, jute, hemp or other fiber with cotton seed oil for the purpose of manufacture generates heat in the mass, and thus becomes a source of danger. Such material should never be allowed to lie in contact with steam or other heating pipes or surfaces, or to be heaped in large piles.

Sawdust should not be used for absorbing waste oil or drippings, unless it be immediately placed beyond harm by immersion in water or burning in a proper place. Sand is the safest material for such use.

Spontaneous combustion is not confined to oily mixtures alone, for water plays a most dangerous part when the proper conditions are present. Sawdust as packing in barrels and boxes becomes a most dangerous element of spontaneous combustion when by accident or neglect it becomes wet. Sawdust in boxes used for drying metal goods after washing is liable to take fire in a few hours. Spreading so that it may quickly dry is the only safe way of using such material. Empty ice houses have been burned by the spontaneous combustion of a heap of damp sawdust left in them. The careless neglect of removing sawdust from sawmills is a fruitful source of fire. Oil or water may be in contact with the dust and air finishes the work of ignition.

The mysterious fires in ships loaded with cotton are probably due to excessive moisture reaching the interior of the bales, or possibly to a bale that had been exposed to rain previous to stowage. The shipment of wet bales is a source of danger. Rags in bales on shipboard contain the elements of combustion in the coloring matter and the grease of cast-off clothing, and are in a ready condition for the reaction of the moist air in a ship's hold. They not only heat, but are in a condition for spontaneous combustion from any excess of moisture. The heating of and occasional fires in large heaps of bituminous coal is due to moisture or exposure to rain. Covering or forced ventilation is the usual remedy.

Fires originating near steam or hot air pipes have been attributed to the partial charring of the wood or fibrous dust by the heat, and its absorption of oxygen from the air. Starch is quickly affected by the heat of steam pipes, and paper holding a starchy constituent is known to become of the texture of punk when left in contact with or near steam pipes, and becomes very susceptible to ignition.

The explosive flash of the impalpable dust of coal, wood, flour and starch, when lodged on the framework of factories and warehouses, is known by sad experience. It only needs a spark or a lightning stroke for a quick-spreading fire. The electric spark from large running belts is a dangerous element in dusty mills.

The heating of hay and grain when stored in mows in a damp condition is well known, and in a few cases has been found to be the direct cause of fire. Probably many of the mysterious barn burnings are due to spontaneous combustion. Corn and other grain stored in large warehouse bins heats to a degree that requires constant aeration by changing its place by conveyors, or the injection and expansion of compressed air. Heating soon destroys the grain, and, if continued by neglect, it becomes liable to spontaneous combustion.

A Moving Mountain in France.

A phenomenon which, from its remarkable character, has attracted much attention in Europe, recently occurred in the department of Gard, France, where Mount Gouffre, a mass of rock 650 feet in height, suddenly gave way at its base and began moving toward Gardon River, upon the left bank of which it was situated. The movement began on the 15th of February, and on the 23d the advance had destroyed the machinery in the pits of the Grand 'Combe Colliery and nearly a mile of the Alais Railway, and had deflected the course of the Gardon 6½ feet. Six hundred persons were obliged to leave their homes at Grand 'Combe, and a water famine having been created, it became necessary to install an engine up stream to pump water from the river to supply the inhabitants of the mining center.

On the 29th the mountain came to a standstill, but it is believed by engineers that this state of rest will be but temporary, and that the rocky mass will resume its motion, cross the Gardon, and finally abut against the mountain that skirts the opposite side of the river. Should this occur, very important geological and topographical modifications will of course be made in the region and it will become necessary to prepare new channels for the Gardon and Gard rivers.

The cause of the accident is shown by the geological structure of the mountain, which consists of grit, green marl, limestone and triassic rocks resting upon a deep bed of clay. These different strata dip at considerable of an angle toward the Gardon. The mountain was therefore influenced by its own weight to follow the slope offered it by this inclined plane. The position was unstable and the danger imminent. Rain or the water of the Gardon must have infiltered and accumulated upon the stratum of impermeable clay, and such infiltrations will have disintegrated certain points of support of the mountain and led to its sliding, which was prepared for by the very arrangement of the ground. The noise made by the mass while it was moving is described as having been frightful.

THE GINGERBREAD TREE.—The Hyphæne thebaica, a species of palm 25 or 30 feet in height, growing in Egypt, Abyssinia, Nubia, and Arabia, produces its fruits in long clusters, each of which contains from one to two hundred. These fruits are of an irregular form, of a rich yellowish brown color, and are beautifully polished. In upper Egypt they form part of the food of the poorer classes of inhabitants, the part eaten being the fibrous, mealy husk, which tastes almost exactly like gingerbread, whence the popular name of gingerbread tree in Egypt.

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A Great German Telescope.

The Berlin Industrial Exhibition opens May 1, 1896, and in connection with it the Astronomical Observatory of Grunewald will be transferred to Treptow near Berlin. One of the features of the exhibition will be photographs of old instruments, models of telescopes, reproductions of astronomical drawings and kindred subjects. As the largest refractor hitherto erected in Germany has only been one of 18 inches aperture, it is gratifying to note that one is now being constructed having an aperture of 28 inches.

The mounting is so arranged as to receive two objectives, of which one is designed for direct visual, the other for spectroscopic and photographic observations. For this reason the latter will be a double objective of short focal length, 20 to 23 feet, and large aperture, 43⅓ inches, which for the present will be exhibited in an unfinished condition, as the means for the purchase and polishing of the enormous lenses, which have been very successfully cast by Dr. Schott, can only be raised during the exhibition. The rough disks of glass for the lenses of the telescope have been furnished by Dr. Schott and Genossen of Jena, while the polishing has been executed by Messrs. C. A. Steinheil of Munich. The mounting of the instrument was intrusted to the Berlin Maschinenbau Anstalt C. Hoppe, "who was assisted" by the firm of G. Meissner, Berlin, in the execution of the minute mechanical portions. The other objective, on the contrary, is completed, and has an aperture of 27½ inches and a focal length of 68 feet.

Instead of the usual dome, the telescope is provided with a cylindrical protective envelope, which together with the tube is mounted on a rigid box, which can be rotated round the declination axis. The polar axis is placed in the interior of the pier; attached thereto, and therefore revolving round it, is a kind of bell, which incloses the observer's seat; the above mentioned box revolves with the bell round the polar axis. The observer sits in the prolongation of the polar axis, in such a manner that his head is in the turning point of the whole telescope, so that he can easily follow its movements by slightly turning his head. The counterpoises for the tube extend at either end of the box; besides which there is attached a second bell, which serves to relieve the polar axis, and for this purpose runs on two antifriction rollers fixed to the pier.

AN IMPROVED SORTING MACHINE.

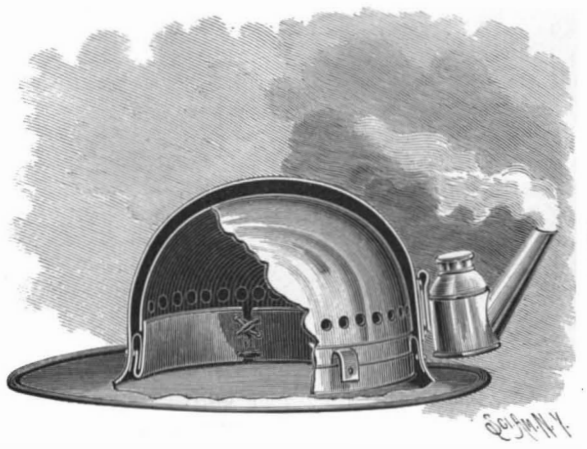
The illustration represents a machine adapted to sort into different sizes not only potatoes and other vegetables and fruit, but a great variety of different substances, the size, strength and other details of the machine being varied accordingly. A patent was recently granted for the improvement to C. G. Poulson, Jr., deceased, of Linwood, Pa., of whose estate C. G. Poulson, Sr., is administrator. Within the box body of the machine is an inclined screening or separating table, mounted to have end motion, the table consisting of slats or bars, which are diamond-shaped in

POULSON'S POTATO SORTING MACHINE.

cross section, and wider apart at the tail than at the head of the table. Beneath the table are hoppers adapted to receive the different sized material passed through the bars at the narrower and wider spaces. The sorting table swings freely on hangers and is moved by turning a crank, on the shaft of which are cams, the table being moved against spiral springs which force the table against a buffer four times for each revolution of the crank shaft. Material shoveled into the machine at the top, as shown in the illustration, feeds automatically to the proper sized openings between the slats, when it instantly drops into the spouts, to be conveyed into bags or baskets, or any desired receptacle.

A SAFETY HAT FOR MINERS.

A hat designed to withstand blows of falling material, such as pieces of coal, rock, etc., and which is thoroughly ventilated and fits easily on the head of the wearer, is shown in the accompanying illustration, and has been patented by James McNamara and Frederick W. Peppler, of Calumet, Mich. The shell and brim of the hat are formed of a single piece of sheet metal, and inside the shell is a lining or inner



PEPPLER & McNAMARA'S MINER'S SAFETY HAT.

shell of suitable textile material, to the edge of which is attached a leather head band. The inner shell and band are somewhat smaller than the exterior shell, and air holes provide for a circulation of air. The band and inner shell are secured to the outer shell by a series of spring clips, the spring of which allows the band or lining to conform to the head. On the front of the hat is a socket plate to receive the hanger of a miner's lamp. The hat is very durable, is waterproof, will not absorb grease from candles or oil, and the lining may at any time be taken out without ripping or tearing it.

Practical Disinfection of Rooms.

The frequency with which second and third cases of scarlet fever appear in houses that have been disinfected by the inspectors of sanitary authorities, says the Lancet, causes grave doubts as to the efficiency of the procedure usually adopted, despite its official sanction. Stripping the walls, lime washing walls and ceilings, and scrubbing woodwork and floor boards with soap and water are indeed effectual enough, and to these when thoroughly done we are disposed to ascribe any successful results rather than to the more technical process of so-called disinfection by sulphur fumes, which is little better than a superstitious rite or incantation shorn of the religious character it had in the mind of Ulysses when he "fumigated" the halls desecrated by the massacre of his wife's suitors after removing the corpses and washing away the blood with a promptness that precluded all thought of other than moral pollution. But in the light of bacteriological experiments dry sulphurous acid fumes, whether generated by burning sulphur or carbonic sulphide, or, as has of late become the fashion, by opening cylinders of the compressed gas, are for all practical purposes useless. The gas would act as a fairly powerful germicide on articles or fabrics previously saturated with water, but its bleaching action precludes its employment in this way with colored materials, carpets, or curtains, and it is as what is called an "aerial disinfectant" that it holds its ground in popular esteem. But aerial disinfection is an absurdity; no one wants to purify the foul air, which is easily enough removed by simple ventilation. In disinfecting a room the true aim is to kill the germs contained in the dust on ledges or in the crevices between the boards, or adhering to the walls and other surfaces, and the dry gas is powerless for this, which is best attained by a sublimate solution of the strength of 1 part in 1,000, or by lime (not white) washing, provided the lime be fresh burnt and caustic; the carbonate or chalk used in whitewashing under the name of whiting, and into which lime is converted by long exposure to the air, being inert. The series of experiments on the infection and disinfection by various means of wall papers, distempers, and other wall surfaces conducted by Dr. Cronberg, under the direction of the late Prof. Uffelmann, at Rostock, showed that subsequent scrapings were invariably and almost instantaneously sterilized by washing or spraying with the sublimate solution, and equally so by lime wash after the lapse of twelve to twenty-four hours. The danger of corrosive sublimate is, we believe, exaggerated, for the smallest fatal dose for an adult being probably three to five grains—equal to at least a quarter of a pint of the solution—accidental poisoning with the solution is practically not probable, and as a further safeguard it might be colored with indigo or "laundry blue." Carbolic acid, which is sold without restraint and is in universal use, is more dangerous on that account, and is, indeed, frequently employed with suicidal intent and with fatal effects. In France, Germany, and Italy sublimate has nearly superseded all other disinfectants and its neglect in this country is inexplicable. As to carpets, curtains, bedding, and clothing, all that is capable of being washed should be plunged in a copper of boiling water for a quarter of an hour and such articles as would be spoiled by this treatment should be disinfected by steam.

How to Find Negatives.

Much time is lost and patience expended in what is very often a futile search for some particular negative. Perhaps an hour, or even more, is wasted by hunting through two or three hundred of one's photographic successes and failures. To obviate this expenditure of time, we would like to suggest a method of indexing that the writer has found very useful.

The pecuniary outlay for the necessary materials is trifling, and is covered by a few pence. Two note books, indexed, are all that one requires. The one contains a numerical, the other an alphabetical, index.

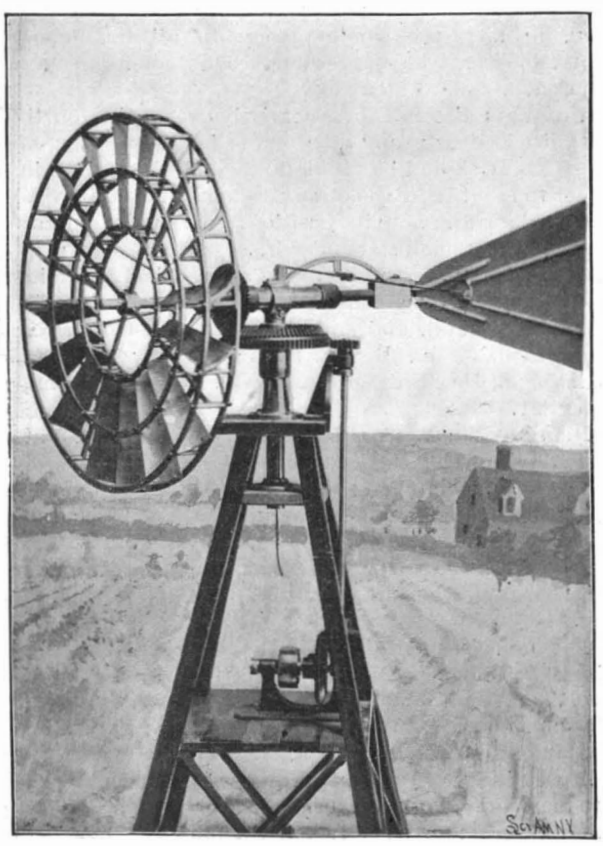
Empty plate boxes are used for storage purposes. Every box should have a gummed label affixed upon the side of the box, each label bearing its own distinctive number. Plate boxes when filled may be kept ranged on a shelf like so many books. A system of double indexing is used.

The numbers 1, 2, 3, etc., refer to the boxes; under the alphabetical headings are found the titles or subjects of the various pictures. A concrete example will perhaps make my explanation more lucid.

One wishes to find a negative exposed, let us say, in Guernsey. Reference to the letter G in the alphabetical index shows one that Mail-boat Approaching Guernsey 6:30 A. M. is stored in box 12. By adopting this method much time and temper is saved.—The British Journal Almanac.

A DURABLE AND EFFICIENT WINDMILL.

The illustration represents a windmill of substantial construction, with thoroughly braced and rigid fans or blades, and powerful gear mechanism for transmitting power from the windwheel to a shaft from which the power may be taken. The improvement has been patented by W. McD. Rowan, of Garden City, Kansas. Secured to the timbers of the tower is a platform supporting a hollow post having an annular flange supporting the main gear wheel, whose hub fits over the flange and rests on ball bearings. This gear wheel has vertical and beveled teeth, the latter engaging a bevel pinion on the horizontal shaft carrying the windwheel, the bearing of this shaft being secured to the upper end of a vertical hollow shaft projecting down through



ROWAN'S WINDMILL.

the hollow post. A curved brace extends from this bearing to the bearing of the hinged tail or vane, which may be moved to throw the wheel out of the wind by means of a cord or cable passing over suitable guide pulleys and down through the tower. The vertical teeth on the main gear wheel mesh with a gear wheel on the upper end of a vertical shaft which has at its lower end a bevel gear meshing with a similar gear on a horizontal shaft carrying a pulley from which power may be taken in the usual way.

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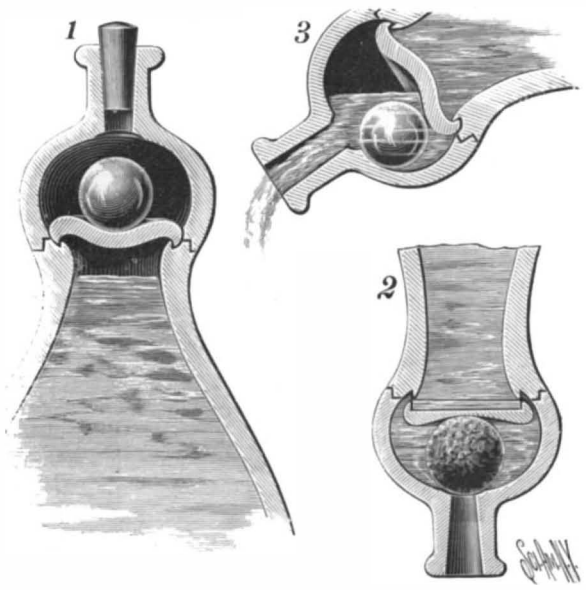
A BOTTLE STOPPER AND MEASURING DEVICE.

A valve stopper designed to prevent the refilling of a bottle after it has been emptied, and one with which the contents of the bottle may be discharged in measured quantities, is shown in the accompanying illustration. The improvement has been patented by Cornelius E. Wyckoff, of No. 365 State Street, Brooklyn, N. Y. Fig. 1 represents the stopper in a bottle, the latter being in upright position; Fig. 2 shows the bottle inverted, its contents then filling a measuring space, and Fig. 3 shows the position of the parts as the measured quantity is being discharged. The cap piece is secured on the bottle by cementing or in other



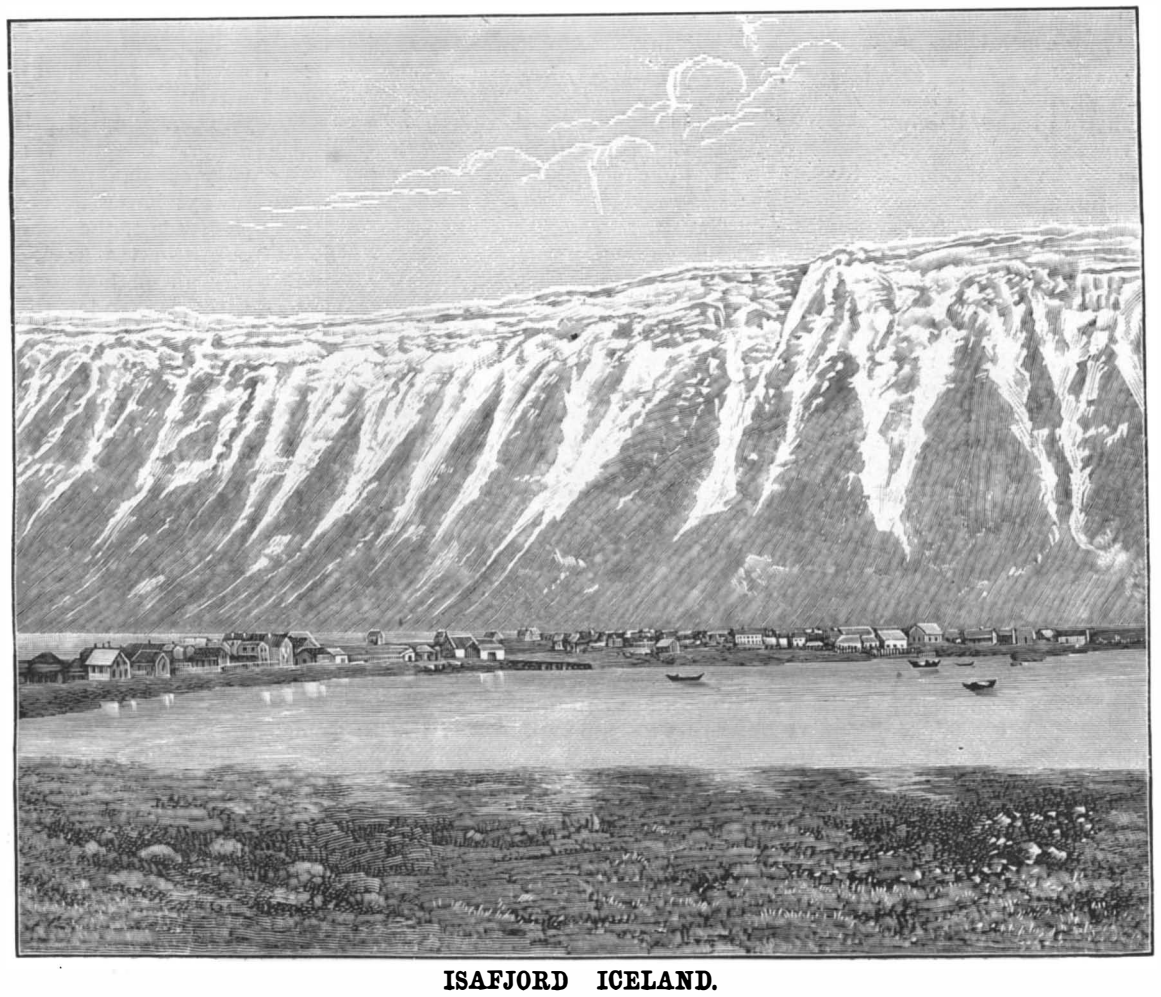
WYCKOFF'S BOTTLE STOPPER.

desired manner, after the bottle has been filled, the interior wall of the cap piece being substantially hemispherical, and having a contracted outlet to be fitted by a cork. About where the cap piece is fitted on the bottle is an annular groove forming a seat for an annular flange of a plate valve, on which rests a spherical body serving as a valve stopper for the inverted bottle, as shown in Fig. 2, while also allowing the plate valve to fall sufficiently away from its seat for the passage of material into the measuring device. When the bottle is tilted to the position shown in Fig. 3, the spherical body rolls to the lower side and forces the plate valve to its seat, thus preventing a further discharge of the contents of the bottle to the interior of the cap, while permitting that which is in the cap to be poured out. Where a continuous flow is desired from an inverted bottle, the spherical body is made with interstices or hemispherical depressions in its surface.

ISAFJORD, ICELAND.

We present an engraving, for which we are indebted to L'Illustration, of Isafjord, Iceland, which is one of the principal seats of the whalebone industry. The scenery here is magnificent, the country presenting the appearance of the fiords of Norway and Sweden. The snow remains on the mountains until the middle of summer. Tourists have had some thrilling adventures in climbing the mountains back of the little village. The bay is capable of holding the largest navy in the world. There are three whalebone fisheries near this place.

Whalebone has become very scarce and it now commands a large price. The name whalebone, under which the baleen plates of the right whale are popularly known, is a misnomer and the trade name of whale fin is equally inaccurate. Of the three kinds of whalebone which are found in commerce, that obtained from the Greenland whale, Balaena mysticetus, is the most valuable, and was one of the great staples of northern countries when the whale fishery was a large industry. To prepare whalebone for the market, the blades or plates are boiled for about twelve hours till the substance is quite soft. In this state it can be cut into narrow strips or into small filaments, according to the use to which it is to be put. Whalebone possesses many unique properties which render it of great value. It is light, tough, flexible, and fibrous. The fibers run parallel with each other without intertwisting. The use of whalebone dates from 1808, when Samuel Crackles patented its use for brush making. Various special machines have since been devised for cutting the material into filaments. Whalebone was formerly used in the manufacture of umbrellas, but steel has now taken its place for this purpose. Whalebone is now principally used by dressmakers, milliners, and brushmakers.



ISAFJORD ICELAND.

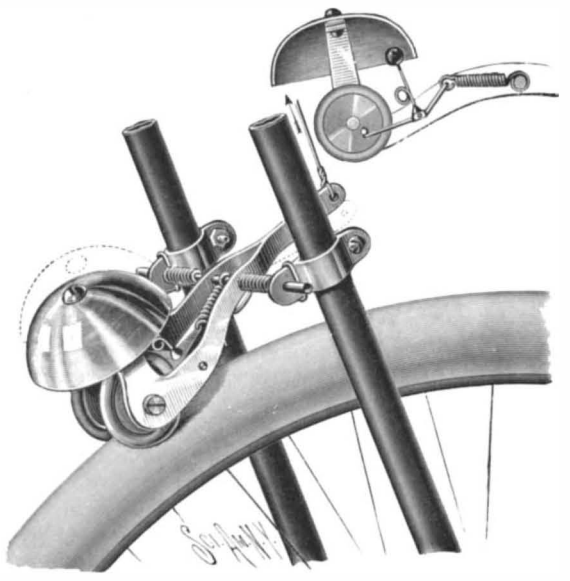
Carpet Moths and Beetles.

In last week's SCIENTIFIC AMERICAN directions were given for preserving clothing and furs from the depredation of moths. We now copy from the Carpet and Upholstery Trade Review directions for protecting carpets and upholstery from moths and beetles. In the good old days, when camphor was sold at a reasonable price, it was the first resource of most housekeepers in their struggles against these villainous vermin, but in view of the extremely high cost of camphor nowadays and the ridiculously low price of carpets, it seems advisable to select some less precious article as a protection against those insects whose appetites work such havoc among woolen floor coverings. Moreover, camphor, however liberally used, is not regarded as a certain protection. Among the substitutes for camphor, which are less expensive and more efficacious, are: Benzine, corrosive sublimate, kerosene oil and carbolic acid. It is said that corrosive sublimate is the only sure defense against the buffalo carpet beetle. In utilizing this drug, take a wide mouthed earthen jar, pour into it two quarts of boiling water and dissolve in this one teaspoonful of corrosive sublimate. As the solution is poisonous, the jar should be plainly labeled and kept carefully covered. When possible it should be used out of doors, and applied with a small whisk brush kept for this purpose only. Gloves should be worn in using it, and care taken to prevent any of it touching the face or eyes. In applying it to rugs or carpets the best method is to hang them over a line, then dip the whisk into the liquid, shaking it nearly all off against the inside of the jar; then carefully brush the rug over both the right and wrong sides, without using enough of the solution to make the fabric wet. It is sufficient to slightly dampen the outside. The liquid will not injure any textile fabric, however delicate.

Benzine or kerosene oil will always kill the insects, if it can be brought into contact with them, and the mere odor of the benzine will kill the larvæ. When it is evident that a house has become infested, the carpets should be taken up and all the cracks and crevices in the floor and under the baseboard filled with benzine, a hand atomizer being used for the purpose. The carpets should also be beaten and then lightly sprayed with benzine. The cracks should then be filled with a mixture of plaster of Paris and water, which will soon set and form a hard substance which the insects cannot enter. In the case of a stock of carpets the benzine spray alone is generally sufficient to kill the insects. The benzine evaporates quickly and leaves no odor, but one should remember that it is very inflammable and that no light should be brought near it.

A NEW BICYCLE BELL.

The illustration represents a bell for use with bicycles, the bell being rung with a continuous electric alarm effect by simply pressing on a lever on the handle bar. The improvement has been patented by Harry B. Breckwedel, of No. 315 West Forty-eighth Street, New York City. In clamps which may be readily secured to the rear braces of any bicycle is journaled a spring-pressed shaft carrying a swinging bell frame, the springs normally holding the outer end



BRECKWEDEL'S BICYCLE BELL.

of the bell frame up from the tire, as indicated by the dotted lines. The bell frame carries, at its outer end, rubberfaced rollers adapted to engage the tire, and on the shaft to which the rollers are secured is a stud adapted to be engaged at each revolution of the rollers, by an arm projecting forward from the hammer, as shown in the small figure, a spring holding the hammer normally out of operative position. From the other end of the bell frame a fine steel wire extends through guides to a lever pivoted on the handle bar, where it may be conveniently engaged by the hand of the user. By pressing with the thumb upon this lever, the hands being in the ordinary position on the handle bar, the outer end of the bell frame is depressed and its wheels are consequently rotated by the tire of the bicycle, each revolution of the small wheels causing a blow to be struck upon the bell and the ringing being automatic as long as the pressure is continued.

Lantern Slides.

A method of making slides for the lantern other than in the ordinary way is described by Dwight Lathrop Elmendorf, who says that, finding the lantern slide was a very useful piece of apparatus in teaching, he cast about for some method of quickly and inexpensively making a slide. Making a transfer one day, the idea was suggested that it might be used on glass. So he placed on a suitable glass a piece of black carbon transfer paper, a drawing being placed on the top and traced upon the glass. When thrown upon the screen the effect was like a charcoal drawing, and answered fully the experimenter's hopes. Unless it is desired to specially preserve the slide, no cover glasses are necessary. He points out that old plates—ordinary or for slides—may be fixed, then washed, and the designs drawn upon them for colored subjects. The method is so handy that it may be practiced before a class.—Photography.

OBSERVATIONS made on the pendulum of the Paris Observatory, which is kept ninety feet under ground, with a temperature that varies one-hundredth part of a degree at most during the year, show that it is not quite proof against the variations of atmospheric pressure. It makes an error of one-third of an oscillation in twelve million, and it is proposed to remedy this error.

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Science Notes.

Hajak, of Vienna, says that smokers are less liable to diphtheria and other throat diseases than non-smokers in the ratio of one to twenty-eight, says the Medical Age. Schiff remarks that smoking should be positively forbidden in bacteriological laboratories, because it tends to hinder the development of the bacteria.

Russia was declared free from cholera on February 24 for the first time since the year 1888.

Scrumpox is a new disease to which football has given rise in England, says the Medical Record. It is a pustular eruption, coming indirectly from dirty jerseys and affecting especially the forwards in Rugby football, who have to shove in scrimmages. It has been proved to be contagious. Bacterioscopic examination has shown the presence of the staphylococcus pyogenes aureus.

The work on Herr Andrée's balloon is proceeding rapidly. A balloon house is to be erected in Spitzbergen. It will be octagonal in shape, 25 meters high and 37 meters broad. The walls and floors will be lined with felt at such points where the balloon will be liable to touch them. The roof will be covered with cotton cloth and the windows will be of gelatine in place of glass. The steamer on which the expedition will set out for Spitzbergen will carry about 35 tons of sulphuric acid to generate the hydrogen.

The St. Louis Observatory at St. Helier, in the island of Jersey, contains some interesting instruments. The observatory is situated on a small, open plateau, above the Jesuit College. It has a tower of the Eiffel type, about 170 feet high; access to the top is obtained by a spiral staircase. A number of instruments at the top are connected by a cable of electric wires with recording apparatus in the observatory proper. Among the special features of the apparatus used is an anemometer of special design. A T-shaped support with orientating arrangement bears on one arm an anemometer with half cylinders instead of the usual cups, being thus made sensitive, it is claimed, to horizontal components and horizontal currents only; while a helical fan on the other arm takes care of the vertical components. It is a curious fact, says Nature, that at this station, as at the Eiffel Tower at Paris, the diurnal variation of wind velocity shows an opposite character near the ground and at the top of the tower; in the former case the velocity reaches its maximum about midday and in the latter about midnight.

In a recent communication to the French Academy of Sciences, says the American Shipbuilder, an explanation is given of some of the curious phenomena pertaining to fog horns. It has been found that, with acoustic signals or sirens, they are surrounded by a neutral zone, in which the sound is not heard at the sea level. This zone is more or less distant, according to the height of the siren on the coast, and it has a main width of about 8,400 feet. On the nearer side of this zone the sound is heard perfectly. But when it is traversed, the sound weakens gradually until it becomes almost imperceptible, when it increases again, and, on the zone being finally left behind, the sound resumes its full intensity. Experiments have been made with a vessel by causing it to approach and recede from a lightship in various directions in a straight line. In each course the sound was deadened almost completely in a zone whose central line was about 15,000 feet from the siren.

Some interesting experiments, by Plateau, in insect vision are recorded in the Bulletin of the Belgium Academy. In a bed of bright colored dahlias he concealed from search the highly colored rays of some of the flowers, exposing only the disk, and in a second series of experiments the disk also, but independently, either by means of colored papers or by green leaves secured in place by pins. Butterflies and bees sought these flowers with the same avidity and frequency as the fully exposed flowers in the patch, the bees particularly pushing their way by the obstacles to reach them. From this M. Plateau concludes that they are guided far more by their perception of odors than by their vision of bright and contrasted colors. In the second communication, says Psyche, Plateau gives the details of another set of experiments to determine whether a wide meshed net presents any obstacle to the passage of a flying insect which could easily pass in flight through the interstices. He found that while such nets do not absolutely prevent passage on the wing, insects almost invariably act as if they could not distinguish the aperture, frequently ending by alighting on the net and crawling through. He reasons that through the lack of distinct and sharp vision, the threads of the net produce the illusion of a continuous surface, seen at a distance.

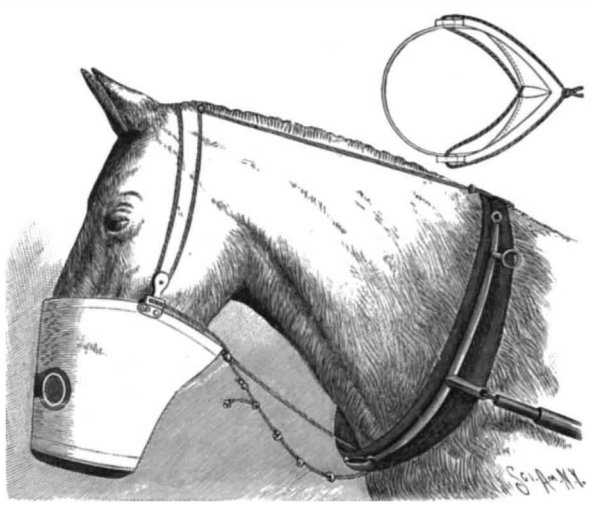
Preparations are being made for an unusual kind of transatlantic trip for a party of American physicians, who intend to start about July 1. The party will be limited to one hundred. Each member must be a physician in actual practice and a graduate of an American university. They will inspect the principal health resorts of Europe. It is expected that various cities will entertain the party officially, and it is believed that they will be received with the greatest courtesy by prominent surgeons and physicians.

The will of Benjamin Franklin was allowed in the Probate Court of Suffolk County, at Boston, on March 26, on the petition of Mayor Quincy, as a foreign will, having been probated in the Orphans' Court in Philadelphia. The probate of the will in Boston was deemed necessary in view of the legal disposition of the "Franklin Fund," which was created by the will of Benjamin Franklin, and which now amounts to several hundred thousand dollars.

The bill to provide for a director-in-chief of the scientific bureaus of the agricultural department has been reported favorably by the Senate committee on agriculture.

FEED SAVING NOSE BAG.

The illustration represents a nose or feed bag adapted to be so applied to the head of a horse that the latter will be prevented from throwing the feed out of the bag by tossing his head. The improvement has been patented by Clement E. Burbank, of No. 31 Eighth Avenue, New York City. At opposite sides of the top of the bag are pulleys through which is passed a cord to form double loops over the head of the horse, and the rear loop is connected by an extension of the cord to the check hook, so that when the horse lowers his head to reach the feed at the bottom of the bag the latter is raised slightly to bring the feed within easy reach. On the inside upper rear edge of the bag are side extensions of somewhat triangular form, which fold over to form pockets, in the edges of which are drawstrings, as indicated by the small figure. Each cord or drawstring passes across the interior of the feed bag at the rear and around a pulley, extensions of the cords being carried back and knotted, to be engaged by a hook secured to the breast collar of the harness. When the horse tosses his head these cords are tightened, drawing the pocketlike extensions in the rear of the bag close against the under side of the horse's jaw, and thus preventing any waste of feed. In taking off the feed bag, these cords are disconnected from the collar and secured around the bag itself, one of the cords passing through a loop on the front of the bag.



BURBANK'S NOSE BAG.

Botanical Notes.

The Candle Tree.—The genus Parmentiera (named after Aug. Parmentier, who did much for economic botany) embraces two American species, the fleshy, cylindrical fruit of one of which may be compared to a cucumber and that of the other to a wax candle. Indeed, in the Isthmus of Panama, the latter (P. cereifera) is termed the candle tree or Palo de Velas, because its fruits, often four feet long, have a striking resemblance to yellow wax candles, and a person entering the forests which are composed of this tree might almost fancy himself in a candle factory, for these fruits are suspended from all the stems and older branches. They have a peculiar applelike odor, which communicates itself in some degree to the cattle fattened upon them, but which disappears if, a few days previous to killing, the food be changed.

The Shoe-black Plant.—Hibiscus Rosa-Sinensis, a well known greenhouse plant, is a native of India, China, and other parts of Asia. In its native countries it is a tree of twenty or thirty feet in height, and bears flowers that are very variable—double, single, red, purple, white, or variegated, according to the particular variety. These flowers contain a quantity of astringent juice, and when bruised rapidly turn black or deep purple. They are used by the Chinese women for dyeing their hair and eyebrows, and in Java for blacking shoes, whence the plant is called the shoe-black plant.

The Toothbrush Plant.—The genus Gouania embraces upward of twenty species of climbing shrubs, most of which inhabit the forests of tropical America. The most interesting of these is the G. domingensis, a common creeper in the West Indies and Brazil. In Jamaica it is called chaw stick, on account of its thin, flexible stems being chewed as an agreeable stomachic. Toothbrushes are also made by cutting pieces of chaw stick to a convenient length and fraying out the ends, and a tooth powder to accompany the use of the brush is prepared by pulverizing the dried stems.

Toothpick Plants.—Ammi Visnaga, an umbelliferous plant, is called the toothpick bishop-weed on account of the use made in Spain of the rays or stalks of the main umbel. These, after flowering, shrink and become so hard that they form convenient toothpicks. After they have fulfilled this purpose they are chewed, and are supposed to be of service in strengthening the gums. The spines of Echinocactus Visnaga are in common use among the Mexicans for the same purpose. The number of these spines upon a single plant is something enormous. A comparatively small plant in Kew Gardens was estimated to have 17,600, and a large specimen at the same place could not have less than 51,000.

The Hand Flower Tree.—This tree, the English name of which is a literal translation of Macpalxochiquahuitl, the somewhat cumbersome name by which it was known to the Aztecs, is the sole species of the genus Cheirosteman. The arrangement of the stamens in the flower of this plant is most remarkable. They are of a bright red, and are united for about a third of their length (four inches), when they separate into five curved clawlike rays, and thus bear some resemblance to a human hand. A solitary specimen of this tree was first discovered growing near the town of Toluco, in Mexico. It was of great age and an object of veneration among the Indians, both on account of the remarkable structure of its flowers, and because they supposed no other tree of the kind existed elsewhere; but forests of it have since been discovered near the city of Guatemala.

The Sack Tree.—From a species of Antiaris (the genus which includes the celebrated upas tree) sacks are made in Western India by the following singular process. A branch is cut corresponding to the length and diameter of the sack wanted. It is soaked a little, and then beaten with clubs till the fiber separates from the wood. This done, the sack formed of the bark is turned inside out and pulled down till the wood is sawed off, with the exception of a small piece left to form the bottom of the sack. These sacks are in general use in Western India.

The Lace Bark Tree.—The tree producing the well-known lace bark of Jamaica is called in that island by the name of Lagetto. The inner bark of this tree (the scientific name of which is Lagetta lintearia) consists of numerous concentric layers of fibers which interlace in all directions, and thus present a great degree of resemblance to lace. It is said that Charles II received as a present, from the governor of Jamaica, a cravat, frill and pair of ruffles made of this material, and it is to this day used for bonnets, collars and other articles of apparel by Creole ladies.

Seeds as Weights.—The beautiful black spotted scarlet seeds called love pease (Abrus precatorius), which are much used for necklaces and other ornamental purposes, are employed in India as a standard of weight under the name of "rati." The weight of the famous Koh-i-noor diamond is known to have been ascertained in this way. The seeds of the carob tree (Ceratonia Silique) are said to have been the original carat weights of the jewelers.

The Clearing Nut.—Notwithstanding the venomous nature of the species of strychnos whence the drug nux vomica is derived, the seeds of another species (S. potatorum) are used in India for clearing muddy water. The natives never drink clear well water, if they can get pond or river water, which is almost always impure, according to circumstances. One of the seeds of the clearing nut tree is well rubbed for a minute or two around the inside of the vessel (generally an unglazed earthen one) containing the water, which is then left to settle. In a very short time, the impurities fall to the bottom, leaving the water clear. Bitter almonds, by the way, are said to be employed for the same purpose in Egypt, and those of kola or sterculia in Sierra Leone. Dr. Pereira states that the efficacy of the clearing nuts depends upon their albumen and casein, which act as fining agents, like those employed for wine or beer.

Whisky Root.—A plant belonging to the genus Anhalonium, of the order Cactaceæ, which has long been known by the name of whisky root, from its effects on the system, which resemble those produced by alcoholic drinks, has recently attracted some attention as a stimulant and nerve tonic new to materia medica. The part of the plant used is what is popularly called the "button." This is sliced by the Indians of Southern Texas, and the small pieces being chewed and the juice swallowed, the intoxicating effects follow, it is said, in about the same time as would those of a drink of whisky. The Indians sit for hours enjoying the beautiful visions of color and other manifestations caused by the intoxication. There are several species of the genus, one of which was known to the Aztecs as peyotl, and the intoxicating effects of which are briefly described by Sahagun.—Hist. Universal de las Cosas de Nueva España.

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THE NEW BRIDGE OVER THE HUDSON RIVER AT NEW YORK.

(Continued from first page.)

that the river navigation should be unobstructed, it was determined by the company to attempt the bridging of the Hudson River by a mammoth suspension bridge, with a great central span of 3,254 feet.

If there is one part of a bridge of greater importance than another, it is the foundations, and in the present case they are of colossal size and carried down to unusual depth. Beneath each tower there will be sunk eight steel caissons, forming in plan an oblong 85 feet by 168 feet between centers of caissons. At the outer corners of this oblong there will be four large caissons 62 feet in diameter; between them will be four 35 foot caissons. These will all be sunk to a depth of about 150 feet below the water level, until they rest upon solid rock. They will probably be sunk by the open dredging process, such as was employed by the Union Bridge Company (the contractors for the present undertaking) in building the Hawkesbury River bridge in Australia. The caissons will be so arranged that the pneumatic process can be adopted if necessary. They will rise to within 10 feet of the water level and will be filled with concrete; above this the piers will be carried up in solid granite masonry to a height of 30 feet above water level. Upon the granite foundation will stand the eight columns of the towers, rising to a total height of 587 feet above the water level. They will be built of steel plates and angles and will be strongly tied and braced together. The river and shore legs of columns will incline inwardly and meet at about two-thirds of their height, from which point they will be carried up as a single construction, as will be seen by reference to our engraving.

Strung across the towers will be twelve steel cables each 23 inches in diameter; each cable will consist of a large number of steel wires, about $\frac{3}{16}$ inch in diameter, laid parallel and bound together with a wire wrapping. The wire composing the cables was originally intended to have an ultimate breaking strength of 180,000 pounds to the square inch, but recent improvements in the manufacture of steel wire make it likely that the engineers will be able to secure wire of the strength of 200,000 pounds to the square inch. On the New York side the cables will be carried down to anchorages which will consist of two solid masses of masonry 180 feet square and 150 feet high. On the New Jersey side they will be carried down through tunnels far into the solid rock and secured to massive plate girder anchorages. The twelve cables will be hung in parallel vertical planes, and contrary to the usual custom, they will not be "cradled." There will be four cables over each of the outside columns of the tower and two over each of the intermediate columns.

To prevent any deformation of the floor of the bridge under the action of a moving load, it will be provided with two large stiffening trusses, each of which in itself will be longer than the central span of the Brooklyn Bridge. Each truss will be 1,600 feet long, 125 feet from center to center of trusses, and 200 feet deep at the center. Their ends will be hinged where they meet at the center of the span, also where they rest upon the towers. They will be divided into 40 foot panels, and at each panel point will be a plate steel girder 7 feet deep and 144 feet long, reaching across the full width of the bridge from truss to truss.

At each panel point the trusses, girders and whole floor system will be suspended from the main cables by twelve steel wire suspenders, which will be attached to the floor beams as follows: Two immediately on each side of the trusses and two at two intermediate points; there will be twelve lines of plate stringers, 5 feet deep, running through the whole length of the bridge, one under each rail. Above each floor beam, and high enough to give headway for the trains, will be a deep supplementary lattice work girder, riveted at its extremities to the vertical posts of the truss. The floor beam will be suspended from this upper girder at two intermediate points of support.

Both top and bottom chords will be braced to resist the wind pressure; the former lightly, the latter very strongly. The trusses will be hinged at the center to allow for a lateral movement, and the wind pressure will be resisted by the enormous dead weight of the trusses and floor system. Under the action of the wind the trusses will move out sidewise and thereby the suspenders will become inclined and will transfer part of the wind pressure directly to the main cables.

The maximum loads for which the bridge is designed are as follows: Dead load, about 40,000 pounds to the lineal foot; live load, 18,000 pounds to the lineal foot; wind load, about 1,600 pounds to the lineal foot.

There will be six railroad tracks, and the bridge is to be strong enough to carry all the tracks loaded with trains from end to end, or a total live load of about 30,000 tons; the maximum strain on each cable will be about 8,300 tons, or a maximum of 100,000 tons on the whole twelve. It will be noticed that the shore spans are not suspended from the cables, but consist of a number of steel trusses carried upon independent piers.

The cables are attached rigidly to the top of the towers, and do not, as usual, rest upon sliding saddles. The variations of strain in the towers, resulting from the alterations of load and temperature, will be as follows: Maximum strain in the river leg will occur under full load and high temperature. Maximum strain in the shore leg will occur under full load and low temperature.

It is estimated that the bridge itself will cost $25,000,000, and the cost of the whole, bridge, approaches and terminal works, will be about $60,000,000.

Should there be no legal or other obstructions, it is estimated that the work can be completed in eight years.

The design illustrated was made by the Union Bridge Company, of New York City. Our thanks are due to Mr. Charles Macdonald and Andrew Onderdonk, of this company, and Joseph Mayer, the engineer, for particulars received.

Defects in Negatives and Their Causes.

BY CHARLES L. MITCHELL, M.D.

So many amateurs are at a loss why certain defects occur in their negatives, and how in many cases they can be obviated, that the following summary of a few of the most prominent may perhaps be of aid to many a disheartened photographer:

Fog indicates either decomposition of the emulsion (a defect common in all extremely rapid plates), accidental exposure to light, over-exposure, or over-development. If the negative is foggy all over, excepting where covered by the rabbet of the plate holder, it indicates that the effect was produced in the camera, either by light leaking through some hole in the bellows, or through flange, woodwork, dark slide of plate holder, or that the plate was over-exposed, or that the sun was shining directly on the lens. If the edges covered by the rabbets are also fogged, it indicates light leaking into the dark room before development, or contaminated developer, excess of alkali, or deterioration of the plate. If the plate is partially fogged, in streaks, it indicates leakage of light at the junction of plate holder and camera, or at the edges or corners of the plate holder, or perhaps a leaky or burst corner of the plate box.

Abundant detail in the shadows, but lack of contrast, and general thinness of the negative, indicate over-exposure, too much alkali in the developer, the use of a spent developer, or using a weak developer for too short a time, or want of light and shadow in the subject.

No detail in the shadows, with excessive contrast, indicates too short an exposure, too great a contrast in the lighting of the subject, or the use of a developer very strong in restrainer.

Clear shadows and weak contrast are due usually to insufficient development.

Round or oval clear spots, with sharp dark edges, are caused by air bubbles clinging to the plate during development.

Pin holes and very fine clear spots are due to either dust on the plate during exposure, or (although the plate makers say not) a dirty, poorly filtered and impure emulsion. Small particles of insensitive haloid salts of silver remain in the emulsion, are not acted upon by light during the exposure, or by the developer, and hence when the plate is placed in the fixing bath, they dissolve out and clear a clear place in the film.

Yellow staining of the film is caused by prolonged development with a developer that is either very old, nearly spent, or contains too little sulphite. Also, by fixing in an old, used up fixing bath. Where the staining occurs after the negative has been fixed and dried, and takes place gradually, it is due to insufficient fixing and the presence of undissolved silver salts.

Irregular lines are due to delay in entirely covering the plate, at once, with developer, thus giving it an opportunity to act longer on one part of the plate than another.

General mottling of the film is due to contact of the face of the plate with impure paper, to imperfect fixing, or to allowing the plate to remain for a long time in a pyro developer, without rocking.

Clear corners means that the lens does not fully cover the plate.

Bare places or patches of uneven density (noticed particularly in films) indicates that the plate or film has not been evenly coated with the emulsion, and that while in some places a pool of it has formed, it has left other places nearly bare.—The Photographic Gleaner.

Witch Hazel Ointment.

Lanolin	oz. 4
Petrolatum	" 12
Glycerin	" 6
Distilled extract witch hazel	" 3
Boroglyceride, 50 per cent solution	" 2

Mix the lanolin and petrolatum; add the glycerin and boroglyceride; lastly, add the extract of witch hazel. Perfume with oil of lavender. This makes an excellent toilet cream.

Correspondence.

Interesting Shadow Phenomenon.

To the Editor of the SCIENTIFIC AMERICAN:

The composing room of this office is lighted by incandescent electric lamps, supplemented with gas jets fitted with Welsbach incandescent mantles. If either illuminant is used singly, ordinary dark shadows are cast when the light is intercepted. When the two lights are burning simultaneously, an extraordinary phenomenon is observed, viz., colored shadows, the direct electric rays casting a dark green shade and the incandescent mantle an orange drab. At the point where the shadows intersect each other the shade becomes denser and of a dark drab color, the green being completely destroyed by the orange drab rays. SAMUEL THOMSON.

Titusville, Pa.

[This seems to be a phenomenon partly of the subjective order, the shadow cast by one light being illuminated by the light of the other. The great difference in color of the two lights causes the difference in the colors of the shadows.—ED.]

Flash Light Powders.

To the Editor of the SCIENTIFIC AMERICAN:

I note that in your query and answer column of the March 28 issue of the SCIENTIFIC AMERICAN, you give several formulas for making photographic flash light powder. One of these is: Magnesium powder, 6 ounces; potassium chlorate, 12 ounces; antimony sulphide, 2 ounces.

I believe it will be well to call attention to the fact that mixtures of this nature, containing potassium chlorate or perchlorate, are extremely dangerous, for several reasons, and the making and handling of them must be carried on with the greatest care. Chlorate or perchlorate mixtures are, in the first place, sensitive to friction. This danger is one which may be met with both in manufacture and use, and especially in transportation.

In the second place, they are liable to spontaneous combustion, due to decomposition, which may set in sooner or later; and third, the explosion of these mixtures is of such a violent nature that serious accidents are most certain to obtain.

A few months ago a photographer's gallery in Chicago was nearly demolished by the explosion of a flash light mixture in which potassium chlorate played an important part, and a few weeks later in the same city a chemist had his right hand so badly torn that it had to be amputated. This was the result of an endeavor to compound a flash light powder in which potassium chlorate was used as the oxidizing agent.

I believe your readers will appreciate this statement, which will serve to caution any of them who are inclined to attempt to make any photographic flash light powder containing potassium chlorate or perchlorate. It will be well for those who are not versed in such matters to leave such mixtures alone entirely. SAMUEL RODMAN, JR.

Chicago, April 18, 1896.

The Fastest Ship Afloat.

This is an age of record breaking; and record breaking for its own sake too. The wish to have the biggest, tallest, fastest, most costly something or other "in the world" is a far more potent factor in modern progress in the mechanical arts than we ever suspect. Unquestionably the development of the modern steamship owes as much to the simple desire on the part of the ship builder to beat somebody else, as does the speed of the race horse or the agility of an athlete. This competition for its own sake has seized upon the builders of torpedo boats and driven them so hard that they are raising the limit for speed by leaps and bounds. It was only late last year that the Sokol startled the marine world by passing the 30 knot limit—for years the goal to which the builder of swift craft had looked as a remote possibility—and yet her record was quickly broken by a French torpedo boat. And now the palm has been transferred across the channel again and Her Majesty's ship Desperate stands as the fastest vessel in the world with a record of over 31 knots, or about 36 miles an hour. One would think this was sufficient; but almost before the little craft has had time to tie up at her dock, the British Admiralty is demanding 33 knots an hour in the contracts for her successors. That is about 38 miles an hour; and as these builders have always reeled a knot or two more than the contract speed out of the little fliers, we may look for a spurt of 34 or 35 knots on the trial trip. That would be 40 miles an hour, or fully up to the all-day speed of an average express train!

Such a speed will not be obtained with a horse power much under 8,000. This is one-fourth the trial trip horse power of the Lucania. The Lucania is of 13,000 tons displacement—these craft will probably be of less than 300 tons displacement. So that the Cunard ship which is 43 times as big only takes 4 times as much power to drive her.

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APPARATUS FOR MEASURING THE SPEED OF PROJECTILES.*

This new instrument for the reliable measurement of very minute intervals of time was developed in some preliminary experiments at the United States Artillery School, Fortress Monroe, Va., in measuring the velocity of projectiles from the new 3·2 inch B. L. field rifle adopted by the army.

In the course of these experiments, which were necessarily limited to two weeks' time, observations were taken at intervals as small as 5 feet, and as many as ten consecutive observations at 5 foot intervals, beginning at the muzzle of the gun and extending to 45 feet distance, were easily obtained from a single shot. This instrument being admirably adapted for recording the passage of the projectile at a number of points of its trajectory, it was made an object to study the law of variation of the velocity of a projectile near the muzzle of a gun. From measurements on the negatives it is clearly evident from each that the velocity actually increases after leaving the gun, a fact which has long been suspected, but which, so far as we know, has not previously been demonstrated experimentally.

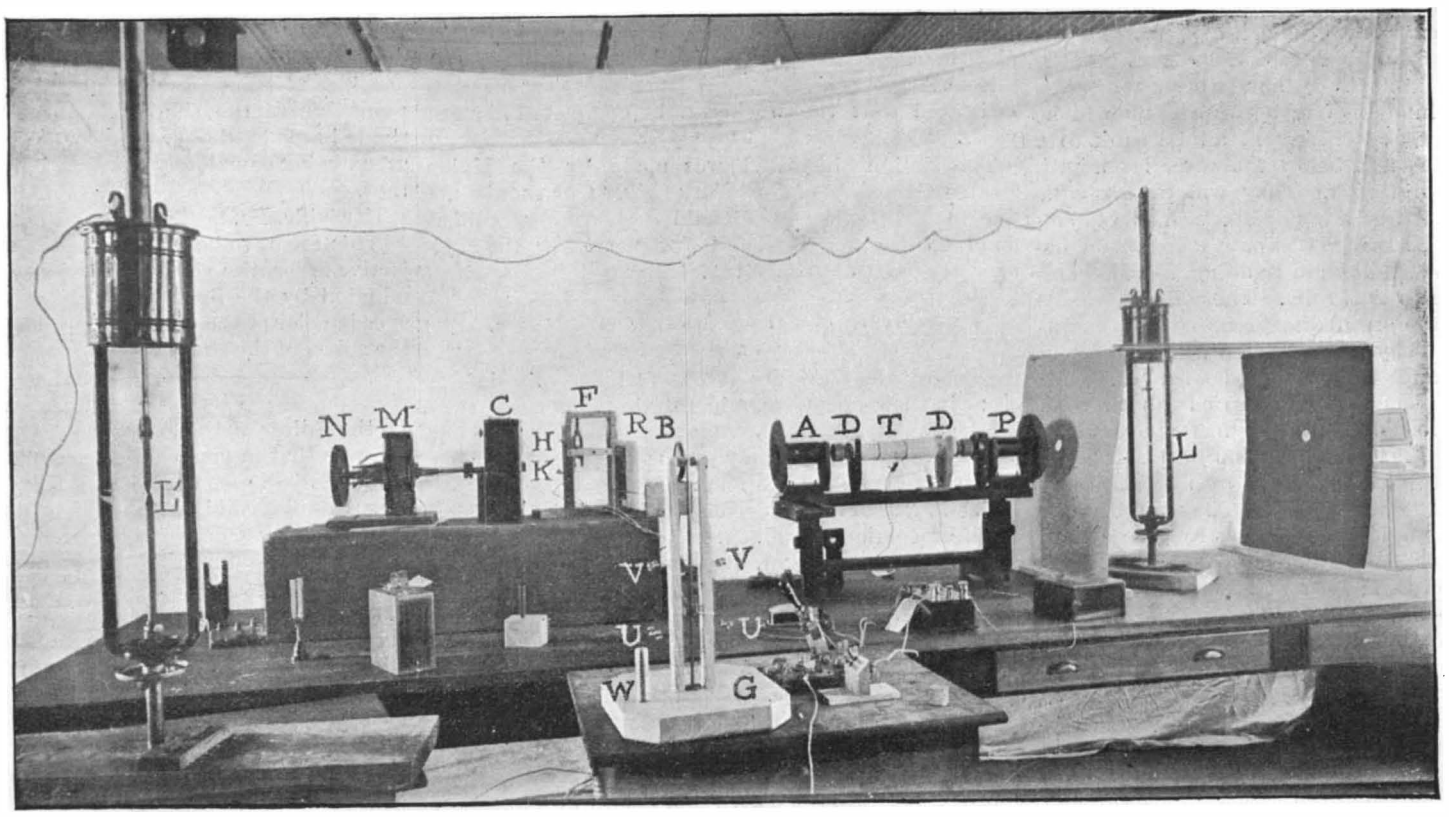

Fig. 1.—ARRANGEMENT OF LABORATORY APPARATUS.

The particular form of transmitter used in these experiments depends for its action upon the use of polarized light. A sensitive photographic plate is made to rotate at a known speed in a light-tight box, and light is admitted to the plate through a narrow slit by means of a "massless" shutter, as the inventor terms it. Any material shutter would possess a certain amount of inertia, and would not admit of a practical result. By the use of a polarizer the light is admitted or shut off without the movement of any material thing.

As is well known, the most efficient polariscope consists of a pair of Nicol prisms. When the prisms are "crossed," the light is totally extinguished, as though the beam had been interrupted by an opaque body. By turning the analyzer ever so little from the "crossed" position, light will pass through it, and its intensity increases until the planes of the prisms are parallel, when it again diminishes, and if one of the prisms is rotated, there will be darkness twice every revolution.

To accomplish the end that is obtained by rotating the analyzer without actually doing so, a transparent medium which can rotate the plane of polarization is placed between the polarizer and analyzer, and made subject to the control of an electric current. The medium used in these experiments was liquid carbon bisulphide, contained in a glass tube with plane glass ends. This was selected because it is very clear and colorless and possesses the necessary rotary property to a considerable extent when situated in a magnetic field of force, the rotary power being in proportion to the intensity of the magnetic field.

To produce a magnetic field in the carbon bisulphide a coil of wire is wound around the glass tube, and an electric current passes through the coil. The prisms being crossed, so that no light emerges from the analyzer, a current is sent through the coil on the tube, causing the rotation of the plane of polarization.

This is equivalent to rotating the polarizer; hence a light now emerges from the analyzer. When the current is broken the medium loses its rotary power and there is again complete darkness. This arrangement makes an effectual shutter for the beam without moving any mass of matter.

A view of the laboratory apparatus is shown in Fig. 1. Fig. 2 shows diagrammatically a complete arrangement of the electrical circuits and apparatus,

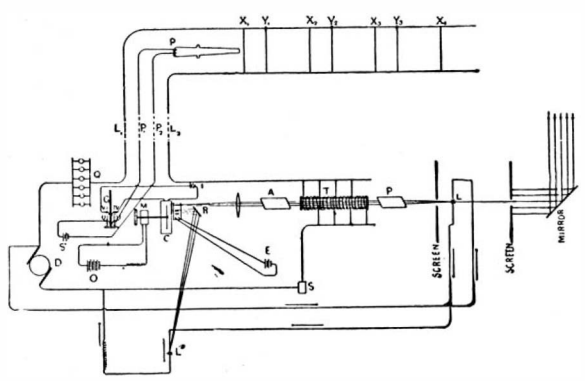

Fig. 2.—ARRANGEMENT OF ELECTRICAL CIRCUITS.

and Fig. 3 shows the apparatus on the proving ground. Corresponding letters represent like parts in the figures.

The arc lamps, L and L', are used as sources of light. P is the polarizer; T, the transmitter tube containing carbon bisulphide and wound with magnet wire; A is the analyzer, in front of which is a lens to condense a beam of light upon the camera, C. The motor, M, revolves the sensitive plate in the camera. The speed of the plate is obtained at the moment of firing by the shadow of one prong of a tuning fork cast by a beam from the lamp, L', reflected from a mirror, R, upon the sensitive plate, the tuning fork being run electrically by the cells, E. At X', X^2, X^3, etc., placed at regular intervals from the gun, are wire screens which are cut one after the other by the projectile.

At Y', Y^2, Y^3, etc. are placed devices for mechanically restoring the current. Before firing, the current passes only through the screen, X', because of an insulating plug placed between the jaws of the device which interrupts the connections between X', X^2, X^3, etc. When the projectile strikes a wire attached to this insulating plug, the plug is pulled out and the jaws spring together, thus establishing the circuit through X^2.

The receiver is a photographic means of recording the intermittent beam of light through the analyzer, and consists of a camera containing a sensitized plate, which is shown in position ready for use at C (Fig. 1).

The electrical tuning fork is shown at F (Fig. 1). Four storage cells were used to energize the motor, and greater uniformity in speed was obtained by placing a heavy iron-toothed gear wheel as a flywheel on the motor shaft, as shown at N (Fig. 1). This wheel also served another purpose in offering a convenient and ready means of determining the proper speed of rotation for a given setting of the camera slide. The wheel contained 56 teeth, and by simply holding on its periphery the edge of a card, with the motor running at an unknown speed, the corresponding note would be given out, and when this was compared with a tuning fork in the other hand of the observer, it indicated at once whether the speed of the motor should be increased or diminished.

The velocity of the projectile is obtained from the measurement of three quantities, the distance between screens, ω the angular velocity of the plate, and θ the angle through which the plate revolves while the projectile passes between screens. This gives the expressions for the velocity $v = \omega \frac{S}{\theta}$. The angle θ upon the plate can be measured with considerable accuracy. In an average case with a distance of 40 feet between screens, angle θ is 108°·0969,

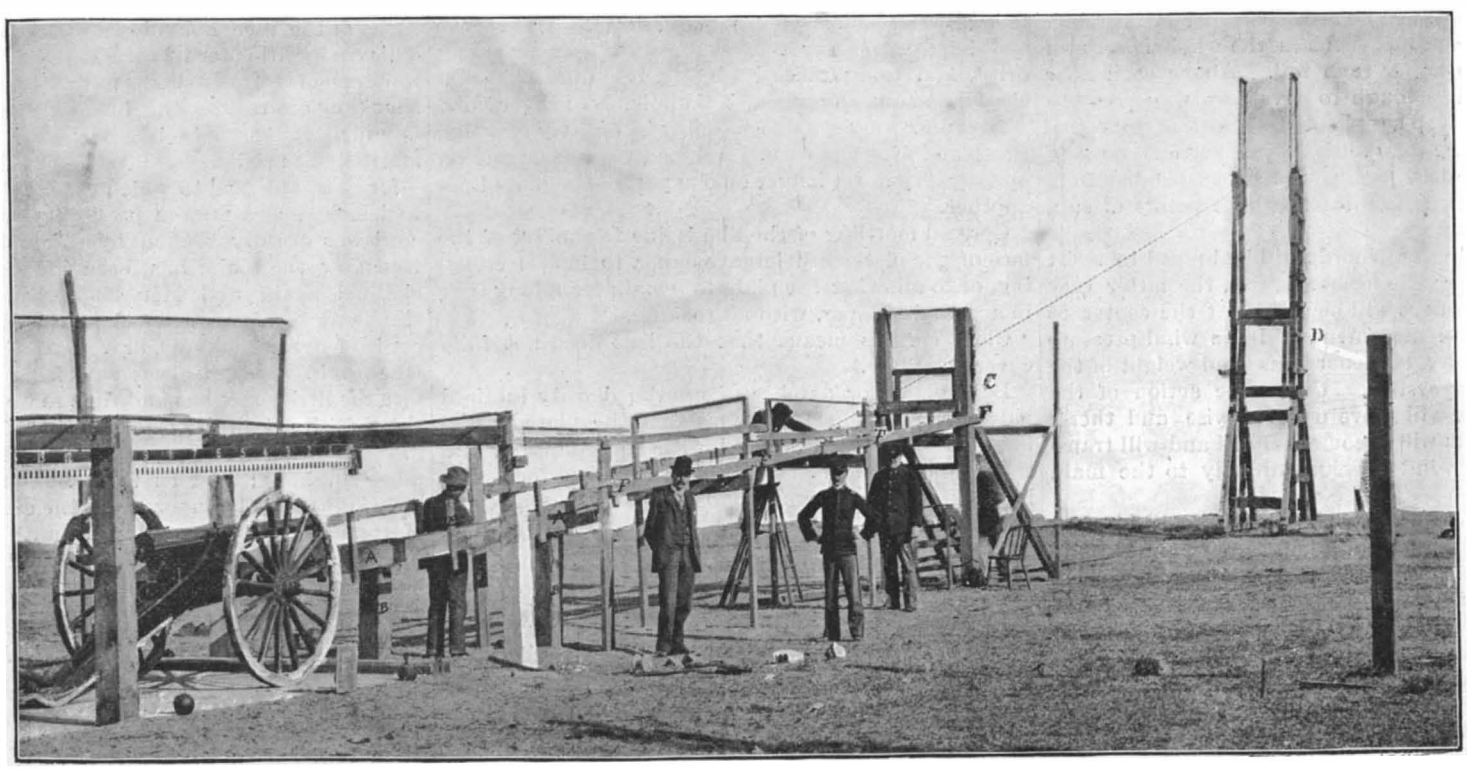

Fig. 3.—APPARATUS FOR RECORDING THE SPEED OF PROJECTILES.

*For the information here given we are indebted to Dr. Albert C. Crehore, Assistant Professor of Physics, Dartmouth College, and Dr. George O. Squier, First Lieutenant, U. S. A., Instructor U. S. Artillery School.

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with a probable error from nine measurements of 0·0074 or an error of one part in 14,630. The angular velocity ω can with proper instruments be obtained with great accuracy.

The principal ballistic result obtained from the experiments may be said to be the locating of a maximum point in the velocity curve outside of the gun. This maximum point is, in the present experiment, at 6 or 7 feet from the muzzle of the gun—certainly more than 5 feet and less than 10—or about 25 calibers in front of the muzzle. The increase in velocity from the muzzle to the maximum point is large, more than 40 foot seconds. The muzzle velocity being about 1,600 feet, this increase is about 2·5 per cent of the whole.

The decrease in velocity beyond the maximum point is comparatively gradual, obeying the true law of the resistance of the air, so that the projectile must travel about a hundred feet before the velocity is reduced to that which it actually had at the muzzle.

This maximum point introduces an error in the present method of obtaining muzzle velocities, in which the velocity is measured at a distance of 100 to 200 feet and reduced back to the muzzle by formulas. The Franklin Institute has awarded the John Scott Legacy medal and premium to Lieut. Squier and Prof. Crehore for this apparatus.*

THE ROYAL OBSERVATORY AND HOW THEY TELL THE TIME AT GREENWICH.

BY DR. D. DUNBAR.

Greenwich, situate on the winding Thames, five miles east-southeast from London, in the County of Kent, possesses a large amount of historical interest. It is the birthplace of many illustrious persons, among them Henry the Eighth, Edward the Sixth, Queen Mary, Queen Elizabeth, and several children of James the First. But it is not of departed kings and queens we propose now to speak, nor of the social attractions of Greenwich. It is a place of great resort, specially on a bright bank holiday.

The observatory building is familiar to every inhabitant of the town, and well known to scientific men all over the world. It stands on the spot once occupied by the tower built by Duke Humphrey. At one time the observatory was furnished with a deep well for the observation of stars in the daytime, but the great improvement in telescopes rendered this unnecessary, and it is now arched over. An apparatus has been erected on the eastern turret of the observatory for the purpose of enabling the captains of vessels leaving the river to ascertain by it the rate of their chronometers, thus obviating the necessity of applying at the observatory. It consists of a large ball of wood lined with leather, which, in order to give preliminary notice, is raised at five minutes before one P. M., half way up a pole, by which it is surmounted, at two minutes before one is raised to the top, and at one o'clock precisely the ball drops. By means of an electric current from the observatory accurate time signals are distributed every hour by the post office telegraphs to a large number of towns, and clocks in the metropolis and country are synchonized. There is in the wall of the observatory a large twenty-four hour clock face, that is, with hours marked from one to twenty-four, to include a day and night; where the time is exhibited at any hour when the park is open for any one who chooses to climb the pleasant hill and look at it.

THE ROYAL OBSERVATORY AT GREENWICH.

The observatory is an oblong edifice, divided into four apartments. It is a quiet, retired spot well walled around, some 150 feet above the average height of the river. The roar of London sounds muffled and distant, and only seems to emphasize the sense of calmness and silence in this abode of science. Here, above the trees of the old park, and on the rim of the mighty city, the astronomers keep the time for half the world. Greenwich time is the standard for the British nation, for British ships at sea, and for the ships of most other countries as well.

We were received by Mr. W. H. M. Christie, Astronomer Royal, and placed in charge of the senior computor, Mr. H. Furnel, to be escorted over the apartments. We soon find that his acquaintance with the interesting and delicate instruments that are explained in turn is much greater than our limited powers of comprehension. But Mr. Furnel, who has become a student of the stars, is a patient gentleman who goes to much trouble in his endeavors to initiate a layman in the mysteries of the heavens.

The main question of this paper is how they tell the time at Greenwich, and we shall endeavor to explain this in popular rather than in scientific language.

The fixing of the standard of time depends on astronomical observations. When the sun is exactly south—on the meridian, as it is called—the hour is twelve o'clock noon. As the movement of the sun apparently fluctuates, astronomers call this apparent noon. At Greenwich Observatory to the study of the sun is added that of the stars for accurately recording the time.

The way of it is this. There are two finely made clocks—the solar clock, keeping the solar time, and the sidereal clock, regulated by observations of the stars.

The sidereal clock is kept as the standard, and every night or day the weather permits, any error is determined by comparison of the clocks. The error of the solar clock is then corrected.

The standard time, therefore, is kept for the nation at Greenwich by constant observation of certain stars, checked by observations of the sun. There are some two hundred and fifty stars calendared at Greenwich, which are known as clock stars. The observations are made with a fine instrument called the transit or meridian circle. Greenwich has the honor of having been the first observatory in the world where a large transit circle was mounted, viz., in 1850. Briefly, it is a large and fine telescope, mounted between two uprights, and pointing exactly to the center line—the meridian—of the heavens, as seen at Greenwich. As the telescope is so hung that it will swing round in, a complete circle between the uprights, it can view any point in this center line of the heavens. The roof of the room in which the telescope is placed can be opened by a sliding or trap door above it, and thus can expose any point of the meridian.

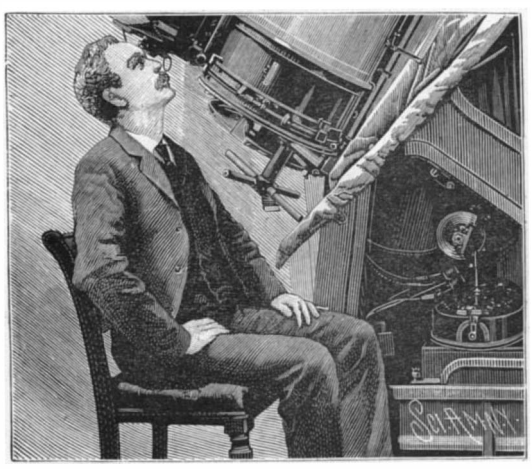
This center line is supposed to be drawn across the heavens from pole to pole of the earth, through the Greenwich zenith; and it is when on this center line in their journey from east to west that the sun and stars are said to be on the meridian. When the sun is on this line, the hour is midday at Greenwich.

In the eyepiece of the telescope are five wires, one of which is exactly on the middle. When, therefore, the star passes this line, it is at the highest, or crossing the meridian. This, however, is not exactly the same as the actual time, because no transit telescope is probably exactly on the meridian line, and the error is corrected by various calculations.

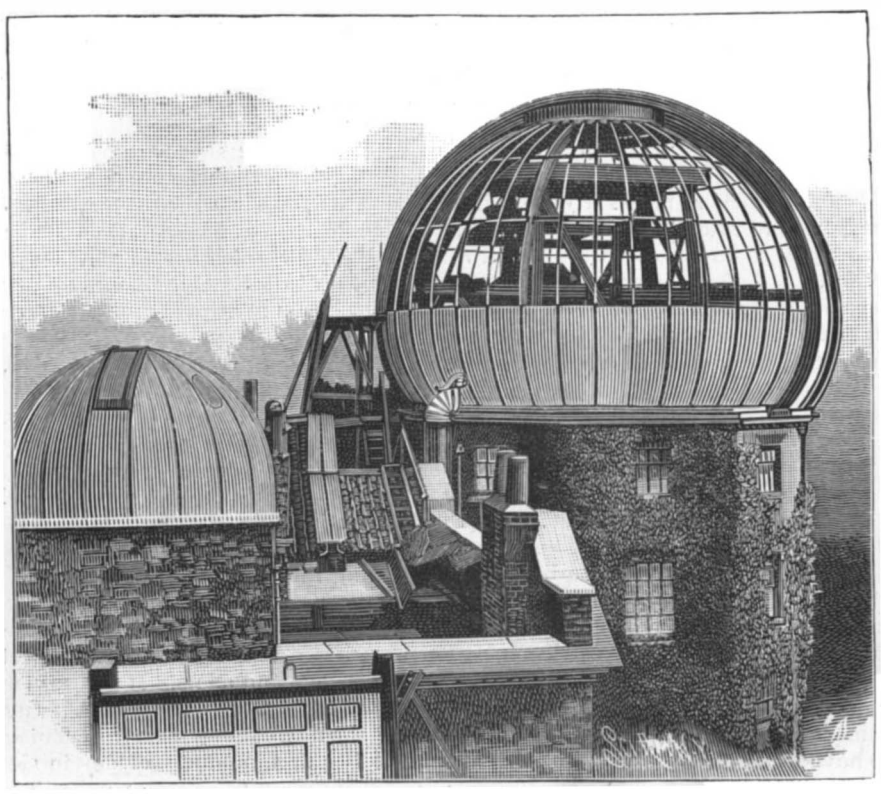
Connected by electricity with the transit circle is a "chronograph," which at Greenwich is on the other side of the courtyard.

The chronograph is a cylinder on which paper is fixed, and on paper is registered the times of the stars'

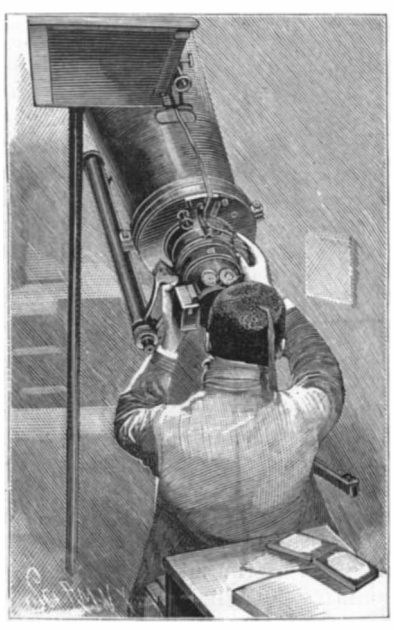
*This apparatus is described at greater length and with additional illustrations in SUPPLEMENT, No. 1054.



THE GUIDER AND PHOTOGRAPHER AT WORK.



ONE OF THE DOMES.



TAKING AN OBSERVATION.

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transit across the fine lines of the telescope. It can also register the seconds of a sidereal clock. By this system of registering the transit of stars greater accuracy is gained and also greater time is permitted to the observer to gaze through the telescope.

But it may still be asked, Why are stars selected to tell the time? Because, for one very potent reason, there is but one sun, and there are so many stars; therefore, so many more chances of good observation. There are very few nights on which some of the 250 clock stars used at Greenwich are not observable. Further, the observations on the various stars may be used to check one another and correct errors, while but one observation of the sun on the meridian can be made.

But how can the passing of the star over the meridian tell the time? In this way: The complete turning round of the earth on its own axis causes a day and night, that is, twenty-four hours, which, in astronomical language, form one day. If, then, a certain star be on the meridian at such a time, it should be on the meridian again, after a lapse of twenty-four hours, at precisely the same time; and the clock, to be accurate, should agree. The earth has made one complete turn round, one complete rotation, and one complete day and night have passed. This is termed a sidereal day, and it is regarded by astronomers as always of the same space of time, because the turning of the earth is regarded as exactly uniform.

The solar day or solar time is measured by the passage of the sun day after day across the meridian, and is four minutes more than the sidereal day. Further, the solar day differs somewhat in length, through the movements of sun and earth; thus the earth moves more quickly in winter than in summer; and these differences are allowed for by astronomers in calculating time. The result is what is called "mean" time.

The reason of the difference of four minutes is that one revolution is added to the diurnal revolutions of the earth on its axis, in consequence of its revolution around the sun in its orbit, so that while there are in round numbers 365 days in the solar year, there are 366 sidereal days. The four minutes per day difference, therefore, makes in the year another whole day, that is, 24 hours 20 minutes. Four minutes saved or lost in a day, you see, make up a whole 24 hours at the end of the year.

But the keeping of the time is not the only work that is done at the observatory. There are ten great telescopes, the largest one being nearly 30 feet long, with an object glass of 28 inches. Over this is a beautiful dome, made like the others of papier maché stretched over iron framework. This gives lightness and strength, enabling the dome to be easily worked on wheels. One portion, opened like a sliding shutter, reveals a strip of sky from the zenith to the horizon; so that by turning the dome round, any part of the sky can be easily and speedily brought under observation.

The large telescope is devoted to the stupendous work of photographing the heavens. About a dozen observatories are engaged in this truly gigantic task, each having a certain portion allotted to it.

All is remarkably quiet at the observatory, Greenwich. Day after day and night after night the observations go forward and the calculations are made. About twenty computers are busily engaged in reducing by calculation the various observations that have been made.

For anything I have been able to say, I am indebted to the astronomer royal and his able assistants; also to those who like myself have visited the royal observatory at Greenwich and made notes, and by comparing notes have been assisted in reaching accuracy.

Bacteria in Milk.*

Bacteria are plants of almost inconceivably minute size. So small are they that in some cases 50,000 might stand side by side and the whole line only reach a length of an inch. They are extremely simple also. Some of them are simple balls, others are short ones and others still are of a spiral shape. But although thus very small and simple in structure, their powers of multiplication are so great as to make them factors of profound significance in the processes of nature. So rapidly can they multiply that in some cases a single individual in the course of twenty-four hours may produce nearly twenty million offspring. This power of multiplication is so enormous we must not be surprised to find them capable of accomplishing by their growth many great changes in nature.

Pure milk, as it is secreted from the udder of the healthy cow, contains no bacteria. If the cow be diseased, this may not be true, but the milk from the healthy cow contains no bacteria when first secreted. Nevertheless, by the time the milk reaches the milk pail it will contain from 30,000 to 5,000,000 bacteria per cubic inch. It is hardly conceivable that the few moments of the milking should be sufficient to contaminate the milk to this extent. We have learned in the last few years, however, the sources of this numerous host.

Part of them, a small part, come from the air; part of them are already in the milk pail. The dairyman never washes his milk pail free from bacteria. Even with the most thorough washing which the pails receive on the ordinary farm the bacteria are not killed, but remain alive, adhering to the cracks in the tin, or in the crevices in the wood. Part of them come from the milker, for he commonly goes to the milking without any special toilet, with his hands not clean, and clothed in the ordinary farm clothes which have become filled with bacteria from numerous sources. But by far the greatest number come from the cow herself. These are not, however, from the interior of the cow, but from her exterior. First, her flanks are always covered with dirt. Frequently they are covered with layers of dried manure, and always the hair of the legs, sides, flanks and tail are covered with a large amount of dust and dirt. All of the dirt and manure is crowded with innumerable hosts of bacteria. Again, the milk ducts of the cow's teats form a prolific breeding place for the bacteria. After each milking some milk is left in the milk ducts, and in this the bacteria which may get to teat from the air or the dirt or hairs of the cow find abundant food. Here they multiply, and by the time of the next milking they are present in countless millions, ready to be washed out with the first milk that is drawn.

From such sources, then, the milk receives its population of bacteria, and these sources are sufficient to inoculate the milk to the great extent mentioned. The great remedy for them is cleanliness. Remembering that the bacteria grow rapidly after getting into the milk and begin to multiply with great rapidity, the value of the immediate application of cold to the milk is plain. The milk when drawn is in just the best possible condition for them to multiply. Immediate and rapid cooling so greatly checks the growth of bacteria as to greatly reduce the number present in the course of twenty-four hours. This is the explanation of the fact that the milk dealer not infrequently has complaints from his patrons that his morning's milk sours, while no such complaints are received of the milk of the night before. The latter was cooled during the night, while the former was taken to delivery at once from the cow or with insufficient cooling. For this reason it actually sours quicker than the milk of the night before, which needs to warm up before the bacteria can grow in it rapidly.

If milk contained no bacteria, it would never undergo any of the common changes which are common in milk, for all of these are produced by the growth of the bacteria. But these bacteria are of many kinds, and even those that commonly get into milk are of many different species. Certainly over 100 different species of bacteria are common in our milk. But these different species do not all produce the same effects on the milk. Some of them sour it by changing the milk sugar to lactic acid. This, as well known, is the most common effect arising in milk upon standing, but others produce other results. Some of them make the milk bitter; some curdle it, but render it alkaline or sweet to taste; others give it an unpleasant, tainted taste; others, again, render it slimy or ropy; some turn it blue or yellow or red.

We are accustomed to think of bacteria as unmitigated nuisances. We think of them as the causes of disease, and if, perchance, we think of them as connected with dairy matters, it is always as the cause of milk souring or some other milk trouble. But the dairyman really benefits from them more than he suffers. Their beneficial effects are shown upon at least two important dairy products, butter and cheese.

Every one knows that cream is seldom churned when fresh. It is allowed to stand in a vessel or vat for a time and undergoes a process which we call ripening, or which is in some parts of the world simply called souring. During this ripening the cream acquires a pleasantly sour taste and a peculiar pleasant odor. This ripening is nothing more than a fermentation due to the growth of the bacteria which are in the cream. During this twenty-four to forty-eight hours the bacteria which were in the cream multiply rapidly, until at the close of the ripening there may be as many as 2,400,000,000 per cubic inch. This growth produces a fermentation, just as the growth of yeast in the brewery malt produces its fermentation.

The object of this ripening is at least threefold. First, it makes the cream churn more readily, and, second, it gives a larger amount of butter from a given lot of cream. The third object is to give flavor to the butter. The explanation of the flavor is simple enough. While the bacteria are growing in the cream they are producing, as they are feeding upon it, certain chemical changes in it. As the result of these chemical changes decomposition products are developed, and these products have various flavors and odors. If the ripening is allowed to continue long enough, the whole mass becomes decayed and the flavors and tastes are decidedly unpleasant. But the first products of decomposition, instead of being unpleasant, are decidedly agreeable, and it is these which give flavor to the cream and to the subsequent butter. After they have developed in the cream, the churning simply separates the butter already flavored with these products. Thus the flavor and aroma of a first class butter are the gifts to the butter maker from the bacteria of the ripening period.

To make good butter, the butter maker needs not only the freedom from the species of bacteria which produce unpleasant flavors, but he needs also the presence of the species which produce the desired flavors. Butter made from cream that comes from the cleanly kept dairy may be depended upon not to develop the unpleasant flavors which arise in butter of cream from the filthy dairy and barn.

But to insure the proper number of proper flavor-producing species simple cleanliness is not so much to be depended upon. In many such cases it is true the proper flavor-producing species will be present, but not always. But why is it not possible to directly inoculate the cream with the proper flavor-producing species, just as the brewer inoculates his malt with yeast? This does, indeed, appear not only to be possible but perfectly feasible, and it involves the use of what are now known as starters. The starter is simply a lot of cream or milk containing a large number of bacteria, which is poured into the cream to be ripened to start the proper kind of fermentation. The starters are of two kinds. Natural starters, which are easily made by any butter maker, and artificial starters, which are made upon a different plan. Our bacteriologists, both of this country and Europe, have been searching for proper flavor-producing species, and having found them, they propose to furnish them in quantity to the butter maker for use in his cream ripening. In the use of these starters the species of bacteria furnished by the bacteriologist is allowed to grow in a small lot of cream until its species is very abundant and then the cream is added to the large vat as a starter. The result is that the butter maker can always depend upon having present a quantity of the proper flavor producing species, and can, therefore, depend with more certainty upon the product. This method of using artificial starters is not new. It has been adopted in Denmark and some other countries of Europe to a wide extent. In this country it has been used only for about a year, and is only just coming to be recognized as a proper method of butter making. The bacteria favorable for this purpose are now upon our markets, two or three different ones being now used in this country. They are generally known as pure cultures, a term which simply means a large quantity of one species of bacteria unmixed with others.

The bacteria are even more needed in cheese making than in butter making. A fresh, flat, curdy taste is seen in fresh cheese. The cheese to be marketable must be set aside for a few weeks to ripen, and during the ripening the flavors develop. This ripening again is simply a fermentation. It is a fermentation of a different character from that of cream ripening. It takes place more slowly and the products are of a different nature, but it is none the less due to the growth of bacteria, and the different flavors of different cheeses are due to the growth of different kinds of bacteria in the cheese. But the problem has proved a difficult one to handle, and while the general facts are easily made out and are demonstrated beyond question, very little in the way of practical results has as yet been reached. A future in this line can hardly be questioned.

*By Prof. H. W. Conn (of the Biological Department, Wesleyan University), in the Spatula.

The World's Wine Production.

The Moniteur Vinicole has recently published a statement showing the wine production of the various countries of the world. From this statement it appears the yield in France amounted in the years 1895 and 1894 to 587,127,000 gallons and 859,162,000 gallons respectively; in Algeria to 83,549,000 and 80,124,000 gallons; Tunis, 3,956,000 and 3,936.000; Italy, 469,555,000 and 539,000,000; Spain, 379.500.000 and 528,000,000; Portugal, 43,890,000 and 33,000,000; Azores, Canaries, and Madeira, 4,620,000 and 2,640,000; Austria, 66,000 000 and 88,000,000; Hungary, 63.030.000 and 46,103.000; and Germany, 80,190,000 and 110,000,000 gallons. In Turkey and Cyprus the production last year amounted to 52,800,000 gallons, and this compares with an average yield of 40,000,000 gallons. In Bulgaria the yield was 26,400,000 gallons; Servia, 17,600,000; Greece, 35,200,000; Roumania, 68.640 000; Switzerland, 27,500,000; the United States, 89,700,000; Mexico, 1,980,000; Argentine Republic, 29,700 000; Chile, 33,000,000; Brazil, 7,700.000; Cape of Good Hope, 2,420,000; Persia, 594,000; and Australia, 3,300,000 gallons.

The World's Fair Awards.

Many of our readers will be glad to know that the long expected distribution of Columbian World's Fair diplomas and medals has begun. On April 20 a considerable number of diplomas and medals were given to Baron Thielmann, the German ambassador, for distribution in Germany. Those awarded to American exhibitors will be ready for delivery in a short time. The excessively long delay is to be deeply regretted.

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Largest and Smallest Books.

Prof. Max Muller, of Oxford, in a recent lecture, has called attention to the largest book in the world, the wonderful "Kuth Daw." It consists of 729 parts in the shape of white marble plates, covered with inscriptions, each plate built over with a temple of brick. It is found near the old priest city of Mandalay, in Burma, and this temple city of more than seven hundred pagodas virtually makes up this monster book, the religious codex of the Buddhists. In accordance with the three parts of which it is composed, generally called in a figurative sense "baskets" (pitaka), the whole is often termed "the three baskets" (tripitaka), and constitutes a library larger than the Bible and the Koran together. As the Jews figured out that the Old Testament contained 59,493 words and 2,728,100 letters, so the Buddhist priests have computed that the "Tripitaka" contains 275,250 stanzas and 8,808,000 syllables. This monster book is written in Pali. Rather strange to say, it is not an ancient production, but its preparation was prompted by the Buddhistic piety of this century. It was erected in 1857 by the command of Mindomin, the second of the last kings of Burma. As the influence of the tropical climate has already marred the inscriptions, a British official, Mr. Ferrars, proposes to have these 729 plates carefully photographed, and asked that the government, or some friend of science able to do so, make provisions for this. Prof. Muller urges that this be done in order to preserve at least the pictures of this unique temple-city book.

A noteworthy contrast is furnished by a recent German literary journal describing what is probably the smallest book in the world. This is a "Konversations-lexikon," published in Berlin, and prepared by Daniel Sanders. The volume occupies the space of only six cubic centimeters (0·366 cubic inch), although it is claimed to contain 175,000 words. The book must be read through a microscope especially prepared for it.—Mining and Scientific Press.

ENGLAND AND THE SOUDAN.

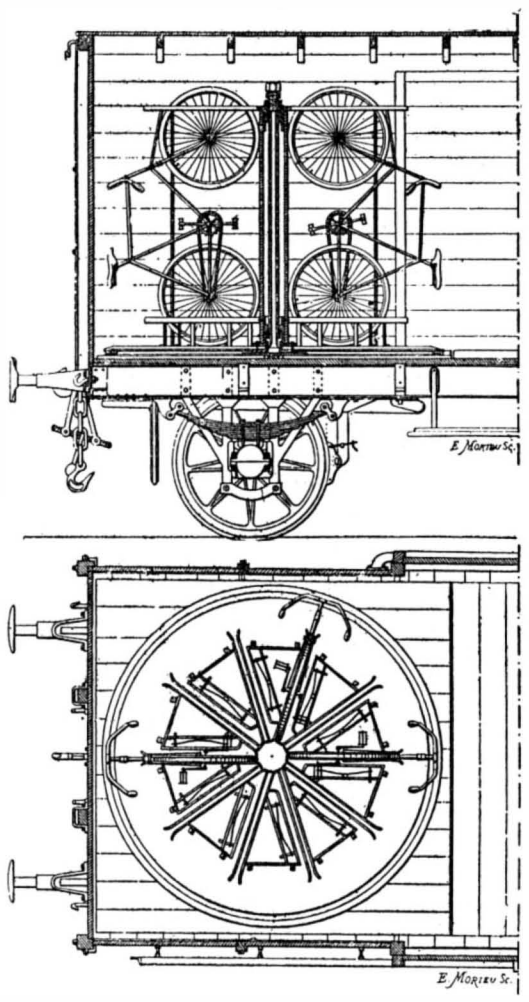
For the accompanying pictures of Soudanese women and warriors, reproduced from photographs by Dr. Jousseaume, we are indebted to Le Monde Illustré. The Soudan includes, in a general way, all the territory south of Nubia and the present British possessions in Egypt to the equatorial lakes, and from the Red Sea on the east to the desert on the west. It is estimated to have a population of from five to seven millions, and is ruled over by the Mahdi, whose seat of government is at Omdurman, and whose lieutenant, Osman Digna, has made frequent raids into the English territories in upper Egypt. To strengthen and possibly advance their frontier, a British expedition of some 9,000 native Egyptian troops, and a contingent of British soldiers, is now advancing up the Nile, although it is not expected that the most serious part of the campaign will begin until September or October, when the rise of the Nile will permit the carrying of supplies for the troops up the river in boats. It is said the dervishes all the time have some fifty thousand men under arms—a force which they could vastly increase without trouble, did mere numbers seem desirable. Famine, disease, the slave trade, and war among the tribes of the Soudan are reported to be thinning out the population.

H. MOISSAN describes two new metallic borides, says the Comptes Rendus, obtained at a temperature of 1,200° C., nickel boride, NiBo, and cobalt boride, CoBo. Both occur in brilliant prisms several millimeters in length and are magnetic. Their densities at 18° are about the same—nickel boride, 7·39; cobalt boride, 7·25. The properties of the borides are analogous to those of iron boride, and the compounds serve for the introduction of boron into a metal such as iron when at a high temperature. It has been demonstrated that both boron and silicon can displace the carbon in molten iron when added in suitable form.

THE CARRIAGE OF BICYCLES BY RAILWAY.

Among the numerous systems of carrying bicycles by railway, now proposed or put into practice, one of the most ingenious is certainly that devised by Mr. J. Oller, and which is at present on exhibition at the third Salon du Cycle at the Palace of Industry, Paris.

The apparatus, which is represented herewith, consists essentially of a turn table capable of receiving ten bicycles arranged vertically around a central pivot from which they radiate and are held in place by two series of forks, which embrace, respectively, the fore wheel above and the hind wheel below. One of the branches of the fork is stationary, while the other, monnted upon springs, is capable of receding from the first through the pressure of the pneumatic tire, which the springs hold in place in such a way as to prevent any tossing about. As a further measure of precaution, the bicycle is held by a strap that passes through the frame near the handle bar. The turn table that supports the apparatus is mounted upon rollers and revolves around the pivot, so as to present to the employe in charge either an empty receptacle or the bicycle that is to be removed from the support.



APPARATUS FOR THE CARRIAGE OF BICYCLES ON RAILWAYS—ELEVATION AND PLAN.

The bicycles thus stowed away are perfectly independent, and well arranged for easy approach when the time comes for putting them off the car. An ordinary baggage car is capable of receiving two of these movable apparatus, say twenty bicycles, and yet leave a free space between them for two bicycles or two tandems. These apparatus may also be placed upon trucks or open cars during fine weather, when a crowd of bicyclists is anticipated upon a line on a holiday.

The same arrangement, mounted upon an ordinary truck, will furnish the ideal vehicle for a system of bicycle transportation analogous to that used in large cities for the carriage of pianos. A special truckman with this apparatus will be able to deliver unpacked bicycles either to private parties, on the account of railway companies or of cycle manufacturers, or to railway stations.

We do not dare to assert that the apparatus under consideration affords a complete solution of the problem of stowing away bicycles upon cars, says La Nature, but, with the present form of machines and their handle bars, we know of none more simple and practical.

Intoxicated Wasps.

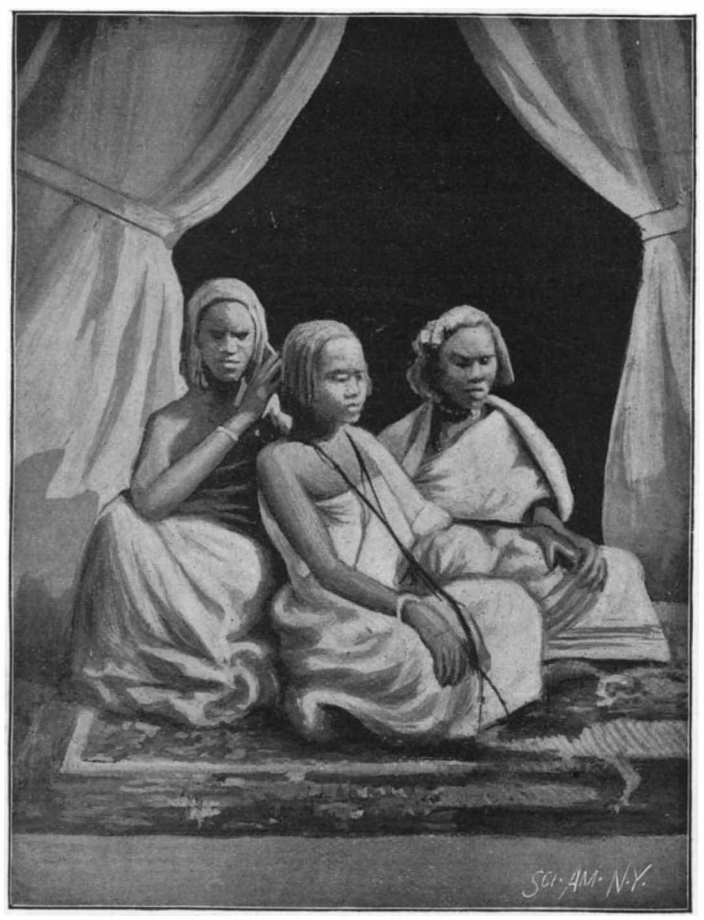
Concerning his observations of wasps which are addicted to the use of intoxicating liquors, Lawson Tait relates the following:

"I have been watching the wasps with great interest and have noticed the avidity with which they attack certain fruit when fully ripe, rotting in fact, and I have also noticed some of the peculiar results of their doing so. The sugar in some fruits which are most attacked by wasps has a tendency to pass into a kind or kinds of alcohol in the ordinary process of rotting, a fact which is easily ascertained by the use of a still not large enough to attract the attention of the excise authorities. On such fruits, particularly grapes and certain plums, you will see wasps pushing and fighting in numbers much larger than can be accommodated, and you will see them get very drunk, crawl away in a semi-somnolent condition, and repose in the grass for some time, till they get over the 'bout,' and then they will go at it again. It is while they are thus affected that they do their worst stinging, both in the virulent nature of the stroke and the utterly unprovoked assaults of which they are guilty. I was stung last year by a drunken wasp, and suffered severely from symptoms of nerve poison for several days. In such drunken peculiarities they resemble their human contemporaries."—Registered Pharmacist.

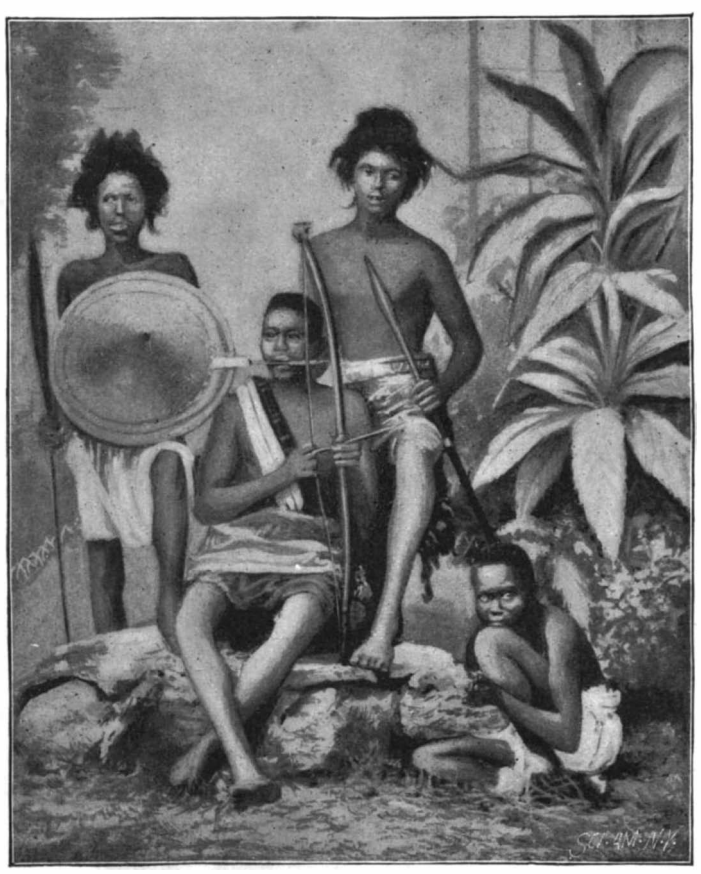
Niagara's Power Transmitted to New York.

A model of Niagara River, the power house, the town and the discharge tunnel will be exhibited at the National Electrical Exposition to be held in New York in May. The model is 12 feet by 4. The turbines will be run for a time each evening with electricity generated at Niagara Falls and transmitted to New York by two copper wires of the Western Union Telegraph Company. Telephones will be connected with instruments at Niagara, so that the roar of the falls may be heard. It is also said that some steps are being taken to deliver some of the current to condensers connected with an Atlantic cable, so that the power of Niagara may be transmitted to Europe.

DR. HOLDEN, of the Lick Observatory, has received the decoration of the Order of Bolivar (of Venezuela) for his disservices to science. He has previously received the decoration of commander of the Ernestine Order of Saxony.



TYPES OF WOMEN AT KHARTOUM.



SOUDANESE WARRIORS.

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Business and Personal.

The charge for Insertion under this head is One Dollar a line for each insertion: about eight words to a line. Advertisements must be received at publication office as early as Thursday morning to appear in the following week's issue.

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RECENTLY PATENTED INVENTIONS.

Engineering.

LOCOMOTIVE TRUCK SPRING HANGER.—Charles Linstrom, Vicksburg, Miss. This hanger has two forks for engagement with the pivots of equalizing bars, the inner members of the forks being rigidly connected with each other, and the forks being adapted to receive the equalizing bars. Each leaf spring extends between two equalizing bars on each side of the truck, and the seat in each hanger is at the center, so that the load is well distributed, and it is not possible to force the springs out of their proper position by heavy shocks or jars.

Railway Appliances.

CAR COUPLING.—Frederick D. Crandall, Sturgeon Bay, Wis. This invention relates to improvements in car couplings of the rotary head type having thin jaws, the coupling being adapted to couple automatically with another similar coupling whether the drawheads are aligned with each other or not, while the uncoupling may be readily effected from either side of the car. The improvement may also be used to couple with cars having the ordinary link and pin coupling.

Electrical.

TELEPHONE BELL.—Richard D. Harrigan, Leadville, Col. This invention provides a simple and quick-acting device whereby the bell will continue to be sounded after the main circuit shall have been opened or cut out, at the main office or elsewhere, and also to ring a bell at a distance from the telephone. An auxiliary circuit is provided, which may be omitted or employed alone, the main object being to set a bell in operation after the first ringing of the telephone bell.

ELECTRIC SWITCH.—Charles G. Bergquist, Chicago, Ill. This is a simple and compact device for attachment to electric fixtures, having the appearance of a gas key, and adapted to turn the electricity on or off as one turns a gas key. An insulated switch arm is carried by a revoluble tubular shaft, two contacts receiving the wires, a ratchet wheel being attached to the tubular shaft and a pawl attached to the support engaging the teeth of the ratchet wheel. A spherical casing is held around the switch by caps screwed into its body, a key passing into the casing screwing into the tubular shaft of the switch.

ELECTRICAL HAIR CUTTER AND SINGER.—Frank M. Bell, New York City. An electrically heated wire or bar, according to this improvement, is practically utilized for cutting and singeing the hair. In a comb provided with a handle are insulated electric conductors, and there are adjustable studs in the comb and comb handle between which is strained a wire or bar of platinum or other refractory material, there being also electrical connections and a button for closing and breaking the circuit. By pressing the button the circuit is completed through the wire, heating it sufficiently to burn the hair in contact with it.

Mechanical.

SHEET METAL GAGE.—Elbridge G. Paull, Fairhaven, Mass. This improvement comprises a rigid or main frame part with jaw, an upright and a lever handle, a compound lever consisting of a jaw with tappet arm and a handle connected together by a spring, and pivoted within the rigid or main frame part, while a pivoted index hand is acted upon by a tappet arm, there being a circular graduated scale, and a spring throwing the lever handles apart. Variations in the hand pressure on the levers make no appreciable difference in the bite or pinch of the jaws, and the gage enables measures to be taken with great exactness and uniformity.

Notes & Queries

HINTS TO CORRESPONDENTS.

Names and Address must accompany all letters or no attention will be paid thereto. This is for our information and not for publication.

References to former articles or answers should give date of paper and page or number of question.

Inquiries not answered in reasonable time should be repeated; correspondents will bear in mind that some answers require not a little research, and, though we endeavor to reply to all either by letter or in this department, each must take his turn.

Buyers wishing to purchase any article not advertised in our columns will be furnished with addresses of houses manufacturing or carrying the same.

Special Written Information on matters of personal rather than general interest cannot be expected without remuneration.

Scientific American Supplements referred to may be had at the office. Price 10 cents each.

Books referred to promptly supplied on receipt of price.

Minerals sent for examination should be distinctly marked or labeled.

(6841) H. De W. asks: 1. What kind of steel should be used to make a permanent magnet? Please give commercial name of steel. A. Tool steel of good quality. 2. To what degree of hardness should the steel be tempered, so that it will retain the magnetism? Should the heating be done by coal, wood or other fire? A. Straw color in a clear fire. 3. What is the best means of magnetizing the steel, to give it the strongest magnetic effect? A. By a magnetizing coil moved from end to end. 4. Will plating with gold, silver, or nickel diminish the attracting or "sticking" of the magnets? A. Almost imperceptibly. 5. Would the application of "mannocitin" lessen the attracting power or adhesion of the magnets? A. Almost imperceptibly, if thin. 6. Will the strength of permanent magnets be impaired by constant contact with the human body? A. No. 7. Do the variations of temperature have any effect upon permanent magnets, and if so, what? A. Increase of temperature tends to lower intensity. There is a certain amount of "trade secrets" involved in the making of magnets. When a particular brand of steel is found best, it is often not disclosed. Information on making permanent magnets will be found in SCIENTIFIC AMERICAN SUPPLEMENT, No. 318, and information on the effect of temperature on same in SCIENTIFIC AMERICAN, No. 4, vol. 73. Very exhaustive articles on magnetism, the construction of magnets and electro-magnets, their physics, etc., will be found in SUPPLEMENT, Nos. 777, 778, 779, 780, 781, 784, 785, 786, 787, 788 and 789.

(6842) J. L. asks how to braze a band saw. A. Scarf the saw ends to match with a lap of ¼ inch, for small saws, up to ¾ inch, for large size. The scarf should not be brought to a sharp edge; it is liable to burn. Bind together with fine iron binding wire, with the laps wet with a paste of borax and water ground on a piece of slate or rough glass. Pin the blade, laid straight, on a large piece of charcoal, ground flat, with a recess excavated under the scarf so as to allow a blowpipe flame to pass under the saw blade. Place a piece of brass or, preferably, silver solder or coin on the upper edge of the lap, with enough ground borax to flow the brazing easily. Heat with a blowpipe under and above the blade until the solder flows, when it will draw entirely through the lap. When cold, file to an even thickness.

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Tube. See Double shell tube.	
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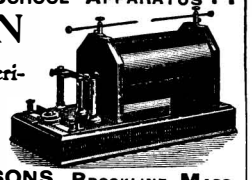

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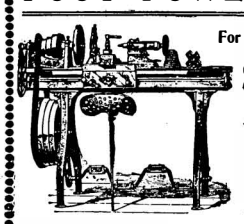

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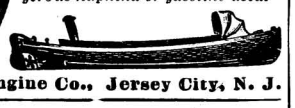

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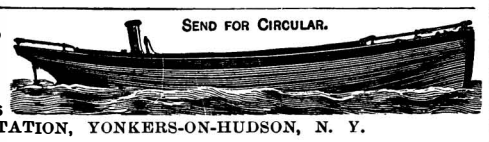

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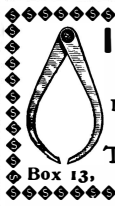

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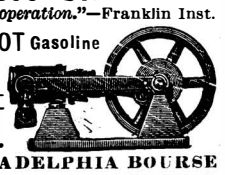

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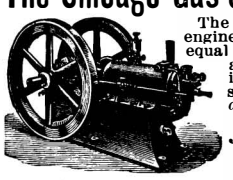

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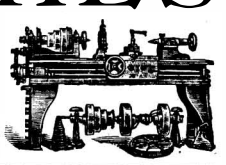

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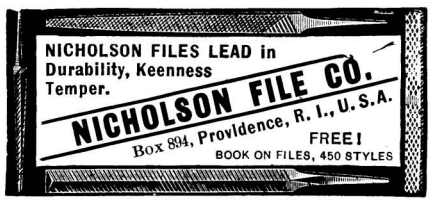

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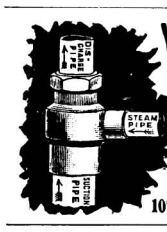

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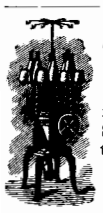

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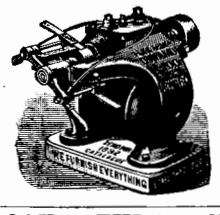

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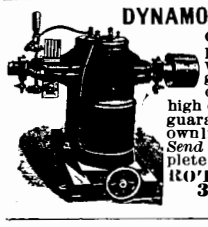

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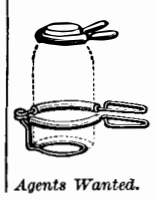

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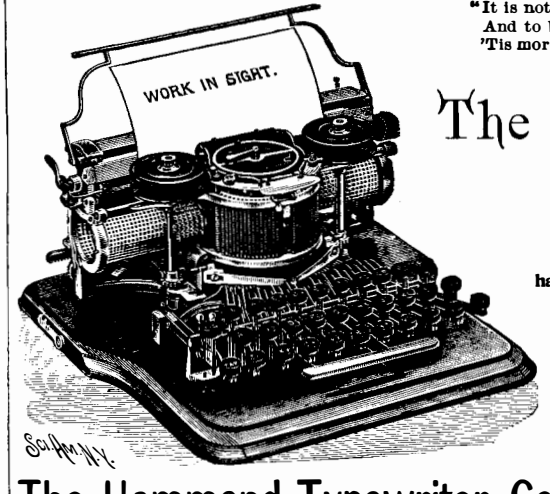

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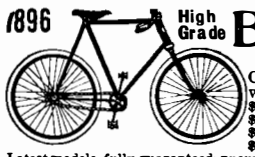

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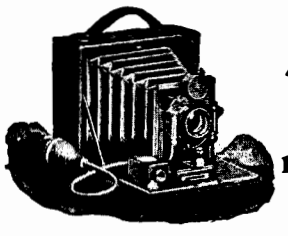

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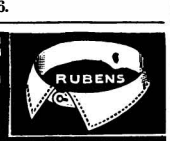

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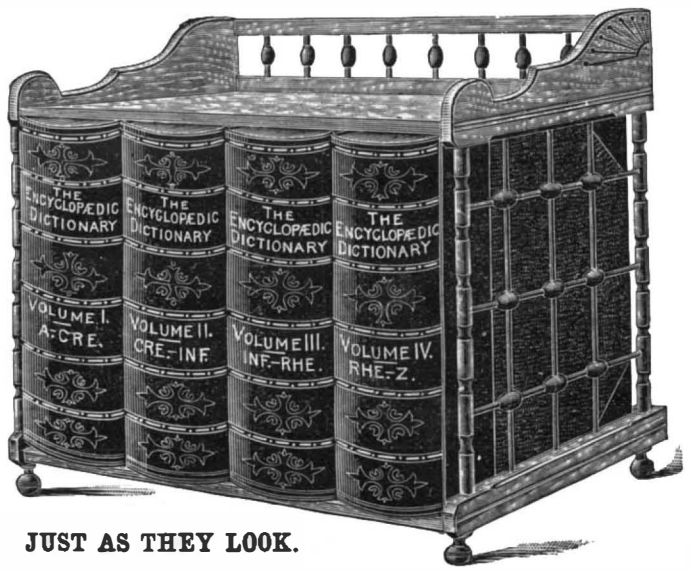

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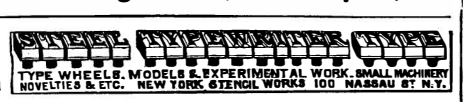

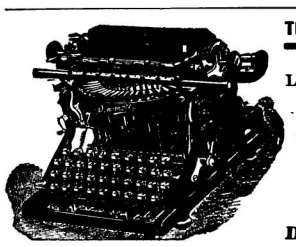

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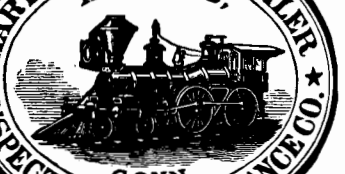

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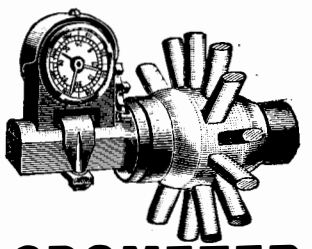

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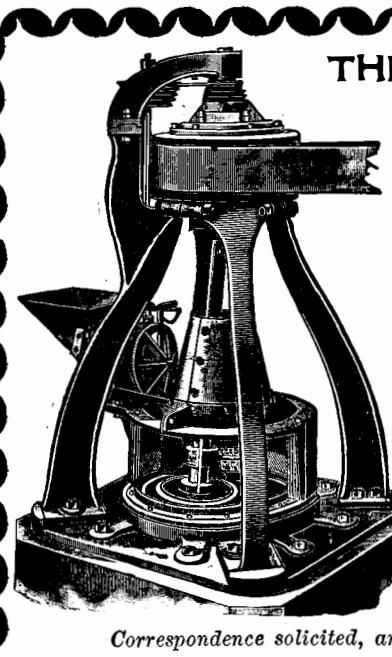

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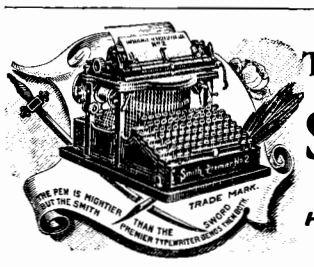

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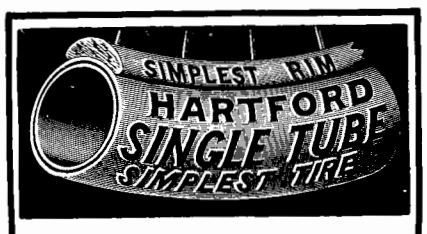

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